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"Pharmacists are considered members of the health team because they practice pharmacy. Regardless of the identification of many practicing pharmacists in the retail field with business unrelated to the practice of pharmacy or the public health, they are considered members of the health team when they function in their specialized professional capacity as registered pharmacists under state laws."—Robert L. Fischella.

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THE AMERICAN JOURNAL OF PHARMACEUTICAL EDUCATION

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**The History
of the
Application of Science
in the Health Field**



**10th Anniversary Conference
AMERICAN INSTITUTE OF
THE HISTORY OF PHARMACY**

in cooperation with the

UNIVERSITY OF WISCONSIN SCHOOL OF PHARMACY

May 10, 1951

Editor: GEORGE URDANG

AMERICAN INSTITUTE OF THE HISTORY OF PHARMACY

MADISON, WISCONSIN

1951

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Welcoming Address

ARTHUR H. UHL

**President, American Institute of the History of Pharmacy
Dean, School of Pharmacy, University of Wisconsin**

It is with the greatest pleasure, indeed, that I open this conference marking the tenth anniversary of the American Institute of the History of Pharmacy and thank you for your participation in it. Ten years is a comparatively short time when we look back. It is a period of considerable length if we pass through it day by day, month by month and year by year, constantly trying not only to do a good job but to improve on it and to live up to the principles and to meet the goal which we have set for ourselves.

From the very beginning of our work, our principles have been those representing the foundation of all scientific work in whatever field it is attempted; honesty in the search for truth and the opening up and use of sources, and the most adequate and useful distribution of the knowledge gained.

We proceeded rather slowly and step by step. Dr. Urdang, who had come to this campus in order to write, in cooperation with Dr. Edward Kremers and using the material brought together by the latter during a lifetime of collecting, had just finished the first systematically compiled history of pharmacy ever written in this country with special regard to the development in the United States. The question was what now.

Here we had on the one side the library of the University of Wisconsin with a particularly strong section of pharmaceutico-historical interest and the collections of Dr. Kremers and, although of a more specialized, botanico-pharmacognostical character, of Dr. W. O. Richtmann. Here was on the other hand a man with proven experience in the pharmaco-historical field and willing to devote himself to the task to utilize this material. Since another offer was made to Dr. Urdang which would have taken him to the East, a quick decision was to be made. At that time there was little or no prospect of an academic representation of the history of pharmacy on this campus. Subject and man had first to prove their

qualifications. Hence there remained only one possibility: to try out the idea of an American Institute of the History of Pharmacy suggested by Dr. Urdang.

This idea, based on the conviction of its originator of the necessity of a center for research, information and distribution of knowledge in the history of pharmacy, had certainly an alluring ring. But could it be realized? Was there any hope for sufficient support for its start first and its development later on? In co-operation with the Secretary of the Wisconsin Pharmaceutical Association, Mr. Jennings Murphy, and joined by the Wisconsin State Board of Pharmacy with Mr. Sylvester H. Dretzka as its secretary, I took the risk. On January 22, 1941, the American Institute of the History of Pharmacy was founded in a classroom of the School of Pharmacy of the University of Wisconsin (and confirmed in our organizational meeting on April 2, 1941) with myself as President and Dr. Urdang as the Director. Both of us are still in the same positions, and I think this is sufficient proof for the continuity in which things have developed.

I do not intend to present to you a detailed account on the development of the American Institute of the History of Pharmacy. Helped into existence and kept alive at first mainly through support coming from Wisconsin, it has from its start enjoyed the moral support and the hospitality of the University of Wisconsin. Gradually the interest of and support by people in pharmacy outside of Wisconsin has grown. We have been especially indebted to the late Dr. Edwin L. Newcomb, Executive Vice-President of the National Wholesale Druggists' Association, and Dr. Rufus A. Lyman, Editor of the *American Journal of Pharmaceutical Education* and former Dean of the College of Pharmacy of the University of Nebraska, who helped to create a general atmosphere friendly to the new venture and to encourage financial support. In Wisconsin the late A. J. Horlick not only showed full understanding for the goals and the work of the Institute but became its most generous donor. Donations from the pharmaceutical industry and the dues of a growing, although still much too small membership, have up to now financed the work of the Institute. At the present stage of development this spotty and uncertain support is no longer

sufficient. Fortunately there is hope for a sound financial basis for the future.

It is always a difficult matter for a responsible officer of an institution to express his favorable opinion on the necessity and the work of his own venture. Hence I am doubly grateful for the message sent to Dr. Urdang by the great man in the history of science, Dr. George Sarton of Harvard University. It reads as follows:

Dear Friend Urdang:

When I received your announcement that the American Institute of the History of Pharmacy was preparing to celebrate its tenth anniversary, I was at first incredulous because I remembered so clearly the documents which you had sent me to announce the foundation of the institute that that seemed like yesterday. Time passes so fast! And yet so much had already been accomplished that my surprise was impertinent.

I wish to express my deep gratefulness first to the late Edward Kremers, who built such good foundations that when the location of the new institute was discussed, it seemed very natural to select Madison. Second, to you, who organized the Institute, gave to it the national importance which it deserved, and made of it a center of study and of knowledge hospitably available to every scholar. The first ten years are the hardest; now that they are passed, let us celebrate and make plans for the future.

I remember that when it was decided to locate the Institute in Madison, I was very happy, because I have always claimed that scientific, artistic, and literary centers should not be clustered together in a few Eastern cities but generously spread across the whole country. It is the same for libraries; none but one, the Library of Congress, can hope to cover sufficiently well the whole area of human endeavor. Of course, every large library, such as the one of the University of Wisconsin, must cover the whole ground superficially, but it cannot answer the deeper needs of every scholar in every field. Instead of that, I wish that each library would select a few fields, which would be more particularly its own. This is particularly obvious and easy in the linguistic fields. There is no reason why every library should try to have all the Polish books, or all the Scandinavian ones, but the interests of every Scandinavian scholar would be served best if he could depend on finding almost every Scandinavian publication in this or that city. Americans who had a constant need of such books would move to that city. And so it is in every field. If somebody wishes to study the history of pharmacy, let him go to Madison, where he will find not only the University and the State collections, but also the rich collections made under the inspiration of Dr. Kremers, of Dr. Richtmann,

and of Dr Urdang. Not only books, old and new, which it is relatively easy to gather, but pamphlets, archives, graphical documents and objects of every kind by means of which the history of pharmacy can be illustrated.

The existence of such a center is of great national value, not only for its immediate purpose, but also for another purpose, which you have never lost sight of, to help to raise the pharmaceutical profession to as high a spiritual level as possible. Indeed, one might argue, that is the main objective. History, the humanities, the memory of hallowed traditions, the grateful recognition of all that we owe to past efforts and to the devotion of great men, it is all that which gives to a profession its nobility and kindles the enthusiasm of generous recruits.

I have no doubt that the American Institute of the History of Pharmacy will become more necessary in years to come than it ever was, because more pharmacists will realize its usefulness, and that it will continue to inspire and to guide a great profession. *Crescat et floreat.*

I am sorry not to be able to be with you today and share your festivities, dear Friend Urdang, but I am with you in the spirit, and I send you my best wishes for the Institute and for yourself. *Ad multos annos.*

Sincerely yours,

George Sarton

Pharmacy is built on the application of science, for the sake of suffering mankind. Perhaps pharmacy is even the most significant representative of this use of science among the health professions. It has been for this reason that we have chosen

The History of the Application of Science in the Health Field as the general topic of this conference. It is understood that every speaker has been given full freedom as to the way of presentation.

The Application of Science to Medicine

GEORGE ROSEN

Editor, Journal of the History of Medicine and Allied Sciences

*Qu'est-ce que la loi naturelle?
C'est l'ordre regulier et constant
des faits, par lequel Dieu régit
l'univers.—C. F. Volney (1757-1820)*

Public alertness to advance in science is a marked characteristic of contemporary society. Scientific progress is expected and accept-

ed as a necessary component of our world. For the public generally, the significance of scientific discovery lies chiefly in its possible relation to human health and welfare. Despite this awareness, however, it is difficult as yet to offer any complete account of the application of science to medicine, and of the factors bearing upon the nature and extent of this relationship. The application of science is so much taken for granted that the dynamic aspects of this process have not yet been subjected to sufficiently intensive analysis. Nonetheless, some elements of the problem are known, and by the use of specific examples it is possible to discuss certain aspects of a theory of the interaction of medicine and science in history.

Science and medicine as we know them are relatively young, but their roots go back to the very beginning of human society. Both have developed in response to elemental human needs, and represent man's continuing effort to acquire mastery of his environment. Thus conceived, science and medicine derive ultimately from the practical activity of the craftsman and the speculative theory of the magician-priest. Archaic medicine and rudimentary science emerged together in the earliest human cultures, and in the civilization of ancient Egypt we find the first step toward a medical science, an effort to explain health and disease rationally.

Medicine is a field where theory and practice meet because of the urgent need for some way of dealing with problems of ill health. Throughout history men have accumulated knowledge about health and disease, and have endeavored to systematize and conceptualize this information. To act effectively the physician must have a body of knowledge and an accepted frame of reference, that is, some concept of the nature and cause of sickness in terms of which he can define and deal with the concrete situations that he faces. Very early in history efforts to develop such formulations led men to apply to medical experience ideas and principles derived from technical operations. These efforts already foreshadow a very significant aspect of our subject, that is, the application of science to medicine on a theoretical level.

The oldest medical literature of Egypt, for instance, offers a theory of physiology and pathology based on the alleged existence in the human body of a system of vessels stemming from the heart

and connecting it with other parts of the body¹. These vessels were believed to be channels for the transportation of various body products, such as blood, urine and others. Disease resulted when these vessels did not function properly. It seems plausible to suggest that this idea derived from Egyptian experience with the irrigation and drainage canals that covered their land, and the conditions that resulted when these were out of order.

Another early example of this type occurs in *Regimen I*, a treatise of the Hippocratic Corpus². In this instance, ideas derived from the techniques of various craftsmen, such as the smith, the potter, the cobbler, the carpenter, are used as clues to an understanding of human physiology. The writer of this work wished to act on the body in such a way that the individual's health would be promoted and preserved. He prescribed exercises, massage, diet, and bathing, and tried to get a clearer understanding of what he has doing by drawing analogies between physiological processes and industrial operations. The analogies are quite fantastic, but the significant point is the approach and the method employed, not the result.

Alexandrian medicine carried this approach one step further by undertaking to explain biological phenomena in terms of a clearly defined physical theory. Strato of Lampsacus, who headed the Lyceum at Athens from 287 to 269, developed a theory of the nature of a vacuum based upon experimentation³. Among his followers was the Alexandrian physician, Erasistratus, whose name has come down to us in connection with his work in physiology. Erasistratus accepted the views of Strato on the vacuum, and they provided the basis for his theory of the vascular system⁴. Certain facts were known to him. He knew that when an artery in a living animal is cut blood spurts from it. He also knew that in a dead animal the arteries contained air, not blood. In addition, Erasistratus was convinced that the division of veins and arteries in the body which could be seen also continued beyond the limits of vision, and that the tissues were made up of these minute subdivisions linked together. But how were these facts related? Erasistratus believed that Strato's vacuum made an answer possible. He concluded that the blood is normally carried by the veins, while the arteries carry air received from the heart. When an ar-

tery is cut the air escapes, creating a vacuum. Through the pull of this vacuum the blood is carried from the veins into the arteries whence it spurts forth. This ingenious explanation was fatally inaccurate, but this does not alter its importance for our theme. Indeed, it leads us to the very heart of the relationship involved in the application of science to medicine.

This relation is both a complex and a changing one. Medicine is a practical activity, aimed at dealing with problems of health and disease. The task of medicine is to promote health, prevent illness, restore the sick person to health, and rehabilitate him so that he may again be a useful member of society. The way in which these health needs are met is determined to a very considerable degree by the availability of scientific and technical knowledge, and by the social and economic organization of the community. Thus, by its very nature medicine raises certain kinds of problems, and these can be considered as so many channels through which science has affected and continues profoundly to influence medicine. This influence may be exerted in terms of theory, as already indicated, or by uncovering new phenomena or introducing new methods of investigation. Historically, the application of science to medicine has proceeded, slowly at first, then more rapidly by collecting, assessing, and accepting or rejecting pertinent data from many sources. This process has passed through several distinguishable phases and to some of these we now turn.

Much might be said about the range and brilliance of scientific achievement in classical antiquity. At Athens and Alexandria the organization and prosecution of scientific investigation reached a high state of development. Solid contributions were made to astronomy, geography, biology and medicine, and the theory of an experimental methodology was outlined. Erasistratus, for example, pointed out that one who is accustomed to investigation undertakes the study of a problem by "worming his way through and turning in all directions," thus directing "his attention to one thing after another which he considers relevant to the subject under investigation until he arrives at the solution of his problem."⁵ Furthermore, this theory was actually applied, as in an experiment which anticipated the better-known one of Sanctoriuss. Erasistratus weighed a

bird, put it into a pot and let it fast, then weighed it again together with its droppings and established that a considerable loss of weight had occurred⁶. Nevertheless, the promise of Greek science was not fulfilled in antiquity, but only after scientific endeavor again began to flourish in the modern world.

While roots of modern science can be traced back into the medieval world, it was in certain European centers during the Renaissance that the Great Restoration was initiated. At the end of the fifteenth century a movement of scientific inquiry became prominent in Italy, south Germany, and the rest of central Europe, including Poland and Hungary. Later the centers of this movement shifted from south and central Europe to France, Holland and England. The period of scientific advance thus initiated extended approximately to the eighteenth century. It was during this period, particularly during the second half of the sixteenth century and the early seventeenth, that those discoveries were made concerning the physical world and the human body which mark the birth of modern science.

The modern period in science emerged out of the interaction of many forces. Economic, social, technological and intellectual factors reacted very intimately on one another. An exceedingly important part in this process of preparation was played by the technical revolution of the Middle Ages. Without the cumulative technological progress of the preceding four centuries, the creators of modern science in the sixteenth century would very likely have been unable to achieve their aims. The development of mines, salt works, foundries, glass works and other industrial enterprises had a special significance for the shaping of a new intellectual climate in which science could develop. The invention of printing made it possible to emancipate such practical knowledge from the tradition of secrecy in which it had been veiled, so as to extend and improve it. This is clearly evident in the learned treatise on mining, the *De Re Metallica* of Georg Agricola, where stress is laid on the relation between theory and application, as well as on the social utility of mining.

Moreover, there were certain other factors at work which tended to operate in the same direction. Increasing wealth of cities and princes, reviving secular interests, and the development of a

new social order based on commerce, money and credit provided a favorable setting for the progress of industrial technology and the creation of new concepts concerning natural phenomena. Desire for wealth as the sinews of war, and an appreciation of the utility of technology in achieving power led rulers and statesmen to encourage men of inventive ingenuity and technical knowledge. At the same time academically trained scholars began to interest themselves in the technical activities of craftsmen. This is clearly evident in William Gilbert's treatise on the magnet, where he shows a knowledge of mining, forging and navigation derived not from learned literature but from miners, foundrymen and navigators⁷. Education also began to show the impact of these trends. Practical knowledge was given greater emphasis in the curriculum. Rabelais, for instance, relates that in rainy weather Gargantua and his tutor went "to see the drawing of metals, or the creating of great ordnance: how the lapidaries did work, as also the goldsmiths and cutters of precious stones. Nor did they omit to visit the alchymists, money-coiners, upholsterers weavers, velvet-workers, watch-makers, looking-glass-framers, printers, organists and other such kind of artificers, and, everywhere giving them somewhat to drink, did learn and consider the industry and invention of the trades"⁸. Fostered and encouraged by these developments, natural science made remarkable progress in the sixteenth and early seventeenth centuries.

The possibility and the importance of applying scientific knowledge for the increase of wealth and the improvement of human health and welfare was first given philosophical form by Francis Bacon. Rejecting vigorously the standpoint that it is "a kind of dishonor unto learning to descend to inquiry or meditation upon matters mechanical," he focused attention on the importance of technical arts and knowledge for the study of nature, and for the use and benefit of man. He gave expression to this claim in a passage so pregnant with meaning and implication for the future that it merits full quotation.

"But if my judgment be of any weight," he wrote, "the use of History Mechanical is of all others the most radical and fundamental towards natural philosophy; such natural philosophy as shall not vanish in the fume of subtle, sublime or delectable specu-

lation, but such as shall be operative to the endowment and benefit of man's life: for it will not only minister and suggest for the present many ingenious practices in all trades, by a connexion and transferring of the observations of one art to the use of another, when the experiences of several mysteries shall fall under the consideration of one man's mind; but further it will give a more true and real illumination concerning causes and axioms than is hitherto attained. For like as man's disposition is never well known till he be crossed, nor Proteus ever changed shapes till he was straitened and held fast; so the passages and variations of nature cannot appear so fully in the liberty of nature, as in the trials and vexations of art."⁹

The new philosophy so trenchantly formulated by Bacon had a profound effect on the development of science and its application to medicine. In fact the advancement of science in the seventeenth century largely drew its inspiration from Bacon, even though the fruits of this influence did not begin to appear before the middle of the century. Meanwhile, important and in some cases fundamental contributions were being made in various areas of scientific investigation. For the most part, medicine as a practical art received very little if any direct benefit from advances in physics, chemistry and biology. Nevertheless, it was during this period and in terms of these accretions of new knowledge that the foundations of modern medicine were laid.

Scientific advance is never uniform nor simultaneous along an entire front. It occurs rather at different times, in varying ways, and in relation to specific areas of knowledge. In some instances, what is required is the discovery and definition of elementary data; in others, where a solid knowledge of elementary factors already exists, fruitful advance can occur through the creation and application of an integrating concept, or by attacking and contributing to the solution of a more complex problem. All of these aspects may be observed in relation to medicine during the period extending from the sixteenth through the eighteenth centuries.

The foundations for an accurate knowledge of the structure of the human body were created through simple, critical observation by Vesalius, his contemporaries and his successors. Thenceforth medical men were able to operate with a comprehensible

view of the body as a structural unit, and all further anatomical investigation and discovery is in a sense simply an elaboration upon this theme.

Equally basic, though on a more complex level is William Harvey's discovery of the circulation. Trained in the school of Padua, Harvey linked anatomy with dynamics, thus providing a firm basis for consideration of the body as a functional system. Harvey went beyond the static confines of anatomy to study the movement of the blood as a problem of mechanical change in space-time.¹⁰ It is significant, however, that the problem that he raised was a mechanical one, not a chemical one. Harvey dealt with a straightforward problem in mechanics, for which a knowledge of anatomical structure was necessary. Owing to the work of Vesalius and Galileo, these were the most advanced branches of biology and physics at the time. Furthermore, there was an increasing use of the experimental method as the decisive test of the validity of any scientific theory. His mind thus having been prepared to raise the right question, Harvey also had at his disposal the means for answering it. At the same time, it is clear that even a great and original scientific mind cannot completely transcend the social and intellectual milieu in which it is immersed. Harvey, for example remained tied to the past in various ways. Philosophically he was an Aristotelian, clinging to a geocentric cosmology, and this is clearly evident in his scientific work.¹¹

Today, when the application of chemistry to medicine is practically taken for granted, it may be difficult fully to appreciate the originality of mind required for such a step in the sixteenth century. Yet this is the very achievement of Theophrastus von Hohenheim, better known as Paracelsus. Like Vesalius and Harvey, Paracelsus also undertook a daring foray into the future. Nevertheless, in terms of concrete achievement the legacy of Paracelsus was far smaller than that of either Vesalius or Harvey, the reason for this is not far to seek. While Paracelsus did indeed force medicine to take notice of chemistry, he dreamed of something for which the time had not yet come. For the problems of medicine there was as yet little or no chemistry to tackle them. Indeed, the very fundamentals of chemistry in general had not yet been laid down, and before this was done it was of small avail to

try to deal chemically with complex biological phenomena. Nonetheless, the attempt was made by the iatrochemists of the seventeenth century. As the theoretical speculations of the iatrochemists exceeded the tested knowledge available to them, iatrochemistry turned out to be a disappointment; and it was not until chemistry was revolutionized at the end of the eighteenth century that it assumed more significance for medicine.

Natural science during this period was characterized not only by the growing use of the experimental method, but also by a disposition to treat natural phenomena mathematically. This trend found expression in medicine in several directions. At Padua, the quantitative study of the body and its functions was actively pursued by Sanctorius. He adapted Galileo's thermometer to clinical purposes, and used a pulsimeter to measure the pulse beat. Best known, however, are his painstaking experiments to record variations in his weight under all sorts of conditions. Others, notably Gian Alfonso Borelli and Niels Stensen, sought to use mathematical principles to explain muscular movement.

Another pioneer development was the application of the numerical method to the phenomena of human society, and particularly to the health and disease of the community. Francis Bacon had equated quantity with mathematics, and treating mathematics as one of the handmaids of physic, pointed out that it "has for its subject some axioms and parts of natural philosophy, and considers quantity in so far as it assists to explain, demonstrate, and actuate them."¹² Inspired by Baconian views, William Petty became a pioneer in the quantitative study of social and medical phenomena. Petty was convinced that such problems could be dealt with most effectively in terms of functional analysis and measurement, what he termed political anatomy and political arithmetic. In the preface to the *Political Anatomy of Ireland*, Petty says: "Sir Francis Bacon, in his *Advancement of Learning*, hath made a judicious parallel in many particulars, between the body natural, and body politic, and between the arts of preserving both in health and strength: and it is as reasonable, that as anatomy is the best foundation of one, so also of the other; and that to practice upon the politick, without knowing the symmetry, fabrick, and proportion of it, is as casual as the practice of old-women and empy-

ricks".¹³ The means for such study is political arithmetic, which Petty described in these terms. "The method I take," he said, "is not yet very usual; for instead of using only comparative and superlative words, and intellectual arguments, I have taken the course . . . to express myself in terms of number, weight, or measure; to use only arguments of sense, and to consider only such causes, as have visible foundations in nature; leaving those that depend upon the mutable minds, opinions, appetites and passions of particular men, to the consideration of others . . ."¹⁴

While Petty coined the term "political arithmetic," and indicated the significance of a quantitative study of social and medical facts, the most valuable pioneer work in this area was done by his friend John Graunt, a London haberdasher. Graunt's classic contribution appeared in 1662 under the title *Natural and Political Observations . . . upon the Bills of Mortality*. In it he reported the results of his search for mathematical regularities in such human events as births and deaths, the incidence of disease, and related matters. Nor was his search in vain, for he demonstrated the regularity of certain vital phenomena. Thus, among the other matters, Graunt was the first to note the excess of male over female births as well as the eventual approximate numerical equality of the sexes. He also called attention to the excess of the urban over the rural death rate. In making these and other discoveries, Graunt clearly demonstrated the utility of the statistical approach which Petty advocated. These seventeenth century pioneers thus opened a path destined to prove extraordinarily fruitful for the future in studying the health problems of community life.

For the most part, progress in science during this period was not achieved in universities, but by practical men who organized themselves in societies devoted to the advancement of experimental science. Such societies were first organized in Italy, and these early Italian societies were the models for Bacon's House of Solomon in the *New Atlantis*. In this connection, Bacon's influence worked in two directions. On the one hand, it stimulated the growth of the new philosophy and its institutionalization in the scientific societies and academies of the seventeenth century. At the same time, however, the utilitarian implications of Bacon's thought led to

proposals for the amelioration of various social problems. Among these, health needs were not overlooked.

In 1641, for instance, there appeared *A Description of the Famous Kingdome of Macaria* by Samuel Hartlib. In this Utopia, Hartlib was interested mainly in proposals for social and economic reform. A special feature of Macaria, however, is a "College of Experience, where they deliver out, yearly, such medicines as they find out by experience; and all such as shall be able to demonstrate any experiment, for the health or wealth of other men, are honorably rewarded at the publick charge."¹⁵ Hartlib also felt that parish priests would be more useful if they acquired some knowledge of healing.

Directly inspired by Hartlib, there was published in 1648 at London a small book of thirty pages entitled *The Advice of W. P. To Mr. S. Hartlib for the Advancement of Some Particular Parts of Learning*. The author was William Petty, and in this booklet presented several proposals for the reform of education. Petty's proposals are in line with a trend found among the Puritans of both the right and the left, namely, a desire to apply knowledge to the immediate and practical needs of society. This finds concrete expression in Petty's scheme. Of special interest is his proposal for a hospital where physicians and surgeons would give and receive instruction. The hospital would be fully equipped with an anatomical theater, a chemical laboratory, an apothecary shop, a garden and a library. Among the chief personnel would be a physician, "skilled at large in the phenomena of nature," who "shall either dissect, or overlook the Dissection of Bodies dying of Diseases; and, lastly shall take care that all luciferous Experiments whatsoever may be carefully brought to him, and recorded for the Benefit of Posterity." In addition, there would be an assistant physician who would maintain suitable records on all patients, a surgeon, and an apothecary who would be in charge of the garden. The young medical student would learn the practical side of his profession by accompanying the members of the medical staff from patient to patient."¹⁶

Petty's proposals stem in a straight line from Bacon's *New Atlantis* by way of Hartlib's *Macaria*, and point to the enthusiastic promulgation of elaborate projects for commercial undertakings.

technological innovations and social reforms during the later seventeenth and earlier eighteenth centuries. Typical is the proposal for a national health service put forth in 1714 by John Beliers, a Quaker cloth merchant of London. Important aspects of this basic scheme are suggestions for the establishment of a systematic connection between the hospital system and the study and practice of medicine, as well as for the creation of a national medical research institute.

The very boldness of these conceptions compels our admiration. While these proposals apparently had no immediately tangible results, they pointed the way to the future. They formed part of a rich intellectual tradition which had germinated in England at the time of Francis Bacon, but of which the first fruitful results for medicine were to be harvested in France during the Revolutionary and post-Revolutionary periods.¹⁷ It was here under the influence of philosophy derived ultimately from Bacon and Locke that the principles of investigation were formulated and applied to provide a firm basis for the further development of modern medicine.

The great scientific outburst of the sixteenth and seventeenth centuries laid the foundation for the application of science to medicine. Nevertheless it did not, as Bacon had hoped, immediately lead to a satisfaction of human needs in relation to health. What it did was to clear the way for approaching the basic problems of medicine, that is, the prevention or cure of ill health. A fundamental step toward this goal was taken by the Paris school of clinical pathologists during the first half of the nineteenth century. Here there emerged for the first time a relatively clear and critical picture of disease entities based upon the idea of a definite connection between clinical observations and autopsy findings. This had already been pointed out by Morgagni in the eighteenth century, but it was the Paris school which made this methodology effective on a large scale. The symptoms which constitute the clinical picture of a disease were now firmly linked to an anatomical substrate which could be identified and manipulated, thus opening up the possibility of observing the mechanism or pathogenesis of disease, and indicating the methodological path to be followed by future research in medicine.

The principles of investigation which formed the basis of the new methodology are best expressed perhaps in the work of Laennec, the outstanding representative of the Paris school, whose researches on diseases of the respiratory tract are indicative of the change. The clinician who worked according to this method observed the manifestations of a disease and followed its course as closely and carefully as possible, with the ultimate aim of pursuing the symptoms into the interior of the body. Diagnosis became an effort to recognize during life pathological changes observed in organs at autopsy.

This reorientation of medicine was accomplished with very simple means and without any modern instruments or methods of precise observation. However, once attention was directed to definite foci of interest such as organs or organ systems, it was only a matter of time before the problem of instruments and methods to facilitate examination diagnosis, and therapy became much more pressing. The introduction of instruments and techniques of precision followed throughout the nineteenth century, until in the twentieth century it has become possible to speak of "machines in medicine."

These scientific and technical trends provided one of the bases for the rise and growth of special fields of medical practice, and the appearance of special practitioners operating within these fields. In fact, one may say that various aspects of modern medicine, such as bacteriology, endocrinology, hormones, modern surgery, which to superficial view seem among its most characteristic features, would not have developed as they did, had not the clinicians and pathologists previously identified and defined diseases in terms of clinical symptomatology and morbid structure.

Distinctions between one disease and another led logically to a search for specific causes. Following the work of earlier workers such as Bassi and Henle, a group of investigators, of whom Pasteur and Koch are most notable, showed that specific bacteria are necessary factors in the production of certain diseases. Surgery also profited from these developments. Stimulated by the localistic pathology of the Paris school, surgeons had developed new procedures and were led in turn to seek for technical improvements. Most important in this connection was the introduction of ether

anesthesia in 1846, and the application of bacteriologic discoveries to surgical technique in the form, first, of antisepsis, and then of asepsis. At about the same time, other investigators discovered that some diseases were caused by a lack of specific substances normally present in the body. Eventually, these studies also led to the isolation of specific "causes" of disease, in the form of dietary elements for which Casimir Funk in 1911 introduced the term vitamins.

Trends in medicine since the turn of the century are too well known to require repetition. All the scientific approaches to medical problems which had been adumbrated in the sixteenth and seventeenth centuries have been extensively and elaborately developed. Experimentation, the application of quantitative methods, the use of precise instruments—all these are quite common at present. And yet the application of science to medicine is in no sense automatic. This is clearly evident in the case of the vitamins. Scurvy, for instance, had been described in the Middle Ages. The role of citrus fruits in preventing or curing scurvy had been recognized as early as the sixteenth century. But even this empirical discovery did not achieve general recognition until the eighteenth century, and then it led to no further progress until the end of the nineteenth century. For advance in this problem, two things were necessary: the concept of deficiency disease, and the existence of technical means to discover just what was missing. As we know, neither of these was present in the eighteenth century, and it was not until the later nineteenth century that chemistry had developed to a point where it could be used for such analysis.

Intellectual milieu and social environment have in various ways influenced the application of science to medicine. For example, the development of a secular, calculatory approach clearly owes much to an intellectual climate derived from machine technology and rational business calculations. Descartes identified the living body with a machine, and this metaphor is more than likely due to the fact that Descartes was an engineer. Indeed, his textbook of physiology is an engineer's view of how the living body works. Thus, to him the pump, valves and forces of the circulatory system were directly comparable with the operation of machines. As an assumption in dealing with the experimental problems of medi-

cine, the concept of mechanism proved increasingly successful. Even though a theory of mechanism might be inadequate as a complete interpretation of biological phenomena, it did make it possible to go a long way toward an understanding of the problems of health and disease. Indeed, mechanical materialism implicitly still underlies a great deal of medical research, and recently in the form of cybernetics has enjoyed a rebirth of popular attention.

With the concept of the machine is linked the idea of rational accounting as the norm for large industrial undertakings. This approach has likewise colored our thinking in many ways. On the one hand, as Ackerknecht has indicated, only in a society where such concepts prevailed could the idea of metabolism as an exchange of material and energy, evolve and be successfully pursued. On the other hand, this idea also illuminates the calculatory consideration of the problem of community health. William Petty's endeavor to compute the "value of the people", Max von Pettenkofer's calculation of the value of health for a city, and the dictum of Hermann Biggs that "Public health is purchasable" are all variations on a single theme. This is the view that activity in the interest of the public health can be measured in pecuniary terms, and that such activity is more likely to achieve acceptance if the results obtained are presented in a pecuniary form. Obviously, such a view could arise only in a community geared to a money economy with a high degree of rationalisation.

These themes are only an aspect of a much broader and profounder social change, namely, the shift of the Western world from a predominantly rural to an urban society, and from a handicraft to an industrial economic order. This is the historical phenomenon that we know as the Industrial Revolution, and which in a large sense made it possible for scientific advances to be applied to medical care.

The application of science to medicine has also reacted upon society, providing social benefits and creating social problems. Thus, out of science applied to medicine have come industries which have grown so that they are now important components in economic life. The pharmaceutical industry, the industries producing medical instruments and apparatus, surgical and orthopedic appliances, in part, the optical goods industry—these are only a few of the

industrial areas in which growth and expansion have occurred because of medical advances arising from the application of scientific knowledge.

These very advances, however, have brought to the fore social problems which press for solution. In our time, medical science and social amelioration have made it possible for increasing numbers of people to live longer. In 1900, for example, there were a little more than 3,000,000 persons 65 years of age and over in the United States. As of 1950, there were more than 12,000,000. There now appears the problem of the aged, because medical advance, the application of science to medicine, is complicated by a social unreadiness to realize the fullest potentials of these achievements.

Similarly, continued progress in scientific medicine during the past seventy-five years has contributed fundamentally to the increasing public awareness of the question of medical care. At the beginning of the present century, there was small public interest in the adaptation of medical knowledge to social needs. Today, the social organization of medical care has become a highly important matter of public policy. The bitter controversies which have raged over this problem, and which still envelope it in a cloud of slogans, indicate how urgently necessary it is to learn from history that advance and solution in this area, as in any other of medicine, require systematic scientific study and intelligent discussion rather than sterile dogmatism and heated ignorance.

The application of science to medicine is a vast subject, which may be considered from many points of view. We have traced certain historical trends, glanced briefly at a few selected current problems, and shall now conclude with some possibilities of the future. The scientific approach to medicine is only now beginning to make itself felt. Immense improvements may be expected through the development of new methods of prevention, diagnosis and treatment. It is known that a large part of disease is preventable and avoidable. Methods of prevention, either through specifics, such as immunization, or through early detection, are available. True, these require refinement and development, but the problem is even more one of social organization than application of natural science. This is especially true of degenerative and

chronic disease. To solve such problems of organization, it is clear that we must look to the social sciences. As the study of human psychology advances, the knowledge acquired will have application to many health problems. Mental and emotional factors are recognized as being of fundamental significance in dealing with the patient as a person. It is becoming increasingly evident also that there is an epidemiology of mental disorder. In this area the application of knowledge and methods from such different fields as demography, individual and social psychology, clinical medicine and statistics will undoubtedly contribute greatly to our understanding of the nature, sources and control of such disorder. With the increasing application of scientific knowledge, prevention will become possible to an ever increasing degree. Yet, one cannot become too sanguine. We all recognize that the possibilities of applying science to medicine are fostered or retarded by problems in social and international relations which transcend the strictly technical limits of the sciences. Clearly the difficulties ahead are very great, and it would be extremely unrealistic to ignore them. Nonetheless, a reasoned optimism is still in order. As the philosopher Alfred North Whitehead, pointed out: "Mankind is now in one of its rare moods of shifting its outlook. The mere compulsion of tradition has lost its force. It is the business of philosophers, students and practical men to re-create and re-enact a vision of the world, conservative and radical, including those elements of reverence and order without which society lapses into riot, a vision penetrated through and through with unflinching rationality." It is as a part of this great task that we must face, understand and meet the challenge of the application of science to medicine.

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Applied Science in Chemical Industry

HENRY M. LEICESTER

**Editor-in-Chief of "Chymia" and Chairman of the Division of History
of Chemistry, American Chemical Society**

The history of chemical industry in all its manifestations, including pharmaceutical chemistry, is closely bound up with the history of chemistry itself. There were times when the practical side of the science was the special concern of one group of workers, the theoretical side, of another group. At other times, the same men were active in both branches. But always each side affected the progress of the other, and the advancement of chemistry as a whole resulted from the mutual interaction of theory and application.

Applied chemistry is, in a sense, the oldest branch. Long before man had any cosmological theories which involved an explanation of the material changes which occurred in the world about him or in his own body, he was bringing about such changes to manufacture materials for his convenience, comfort, and health. The discovery of fire probably first gave him control over processes which we now call chemical. The discovery of methods for smelting metals, tanning skins, dyeing cloth, brewing beer, extracting medicines from plants, and carrying on similar trades began before the dawn of the earliest civilizations known to us. Many of these processes, and particularly those relating to the manufacture of luxuries, were associated with temples in the civilizations of Egypt and Mesopotamia. Although the priests themselves probably did not carry on such trades as metal working or dyeing, they must have known many of the details of the technical methods employed. Since they were the physicians, they must have had an extensive knowledge of the preparation of drugs. They sometimes used their knowledge of technical matters in formulating their cosmological theories. For example, it is probable that the Egyptian priests, acquainted with the origin of meteoric iron which was the earliest form in which the metal was known, and from which it derived its Egyptian name "metal of heaven", used this knowledge in expressing the idea that the sky was a

plate of iron.¹ Yet it cannot be said that during the millenia when the Egyptians and Mesopotamians were developing a class of skilled practical workers in fields now regarded as chemical, that they were developing any definite ideas of the nature of the materials with which they worked.

Such a development awaited the thinking of the Greek philosophers. The cosmological explanations of the Ionian school contained much that concerned the changes of material substances, and these ideas, combined with the speculations of the Pythagoreans and other groups and passed through the interpretation of Plato, finally resulted in the Aristotelian doctrine of the four qualities. His well known concepts, especially as expounded in the fourth book of the *Meteorologica*, which has justly been called the first textbook of chemistry, gave a self-consistent body of ideas which could be applied to most of the chemical facts known to the ancient world².

It is important to remember, however, that the theories of the Greek philosophers had little influence on the practical chemists of their own day. The workers with metals and dyes continued to use the traditional methods of their forefathers, and the Stockholm and Leyden papyri³, compilations of technical recipes made in the third century A. D., are essentially similar to a text on glass making dating from the seventh century B. C. found in the Royal Library of Assurbanipal⁴. The Greek philosopher speculated, but did not soil his hands with the manual labor of experiment; the artisan, very skillful in many cases, carried on his traditional chemical arts without seeking to explain the facts which he observed. While such conditions prevailed, advances in chemistry were limited. The era now came, however, when for the first time theory and practice were united, and chemistry made its first great advance.

The Hellenistic culture which reached its highest point in Alexandria near the beginning of our era produced a new type of philosopher. No longer was manual labor held to be unworthy of the thinker; no longer was the artisan held rigidly to his temple compound. The men who worked with metals were acquainted with the theories of the philosophers, especially those of Aristotle, and they soon applied these ideas to their own work. For the first

time in the history of chemistry, theoretical concepts were used to predict the probable course of chemical change. The growth and perfection of metals striving to become gold over long periods of time and deep in the earth, implied that a similar change might be produced more rapidly by artificial means in the workshop of the artificer. Practical knowledge of the preparation of alloys which resembled gold so closely that, for the purposes of the artisan, they were actually gold, gave every reason to believe that such transmutation was both possible and practicable. About the first century A. D., alchemy arose in Alexandria among a small group of skilled workers. The results were influential for the next fifteen hundred years. The early alchemists evolved theories of chemical change, they invented apparatus, and they devised experiments which gave promise of establishing a true science of chemistry⁵. The blend of theory and practice brought about the most active and fruitful period in the history of chemistry which had yet existed.

Then a shift occurred in the intellectual atmosphere. Mystic philosophies and religions from the east became more influential. Gnosticism and Neoplatonism assumed dominance, and insisted that true knowledge could be obtained only by revelation. Astrology and magic, always present, were fitted into the mystic form of thought. The alchemists soon came under the influence of these ideas. By the fourth century, the creative period of alchemy was over. The ideas of transmutation, with their intense psychological appeal, were given a mystical symbolism, and practical chemistry was once more divorced from theory. The artisans continued their work as before, and the occasional recipe books from the Middle Ages show that they continued the crafts of their predecessors, in many cases virtually unchanged.

The results of the creative period of alchemy were not, however, completely lost. Through Syriac and Arabic translations of the Greek manuscripts, alchemy moved to Mesopotamia and Persia, where it encountered ideas from as far east as China. These Chinese ideas, involving as they did the possibility of curing disease and obtaining long life, or even immortality, by means of alchemical gold, gave to the alchemist an interest in health which fitted easily into later theories of iatrochemistry. Finally, the theories

of the alchemists were distributed through the Islamic world as far west as Spain. With the revival of learning in the twelfth century, they were transmitted back to western Europe.

The Europe which received this Hellenistic alchemy with its Arabic additions still retained its guilds of craftsmen, often practical chemists, but it had almost completely lost the theoretical ideas on the nature of material change. When men began once more to speculate, it was natural that the group which felt the greatest interest in chemical matters should be the physicians. The Galenical idea of the four humors, originally derived from the four Aristotelean elements, predisposed the minds of physicians to accept the explanation of material change which involved the inter-conversion of the four elements, acting through sulfur and mercury, which were the immediate constituents of all things. The iatro-chemical school, which stemmed from the great influence of Paracelsus further caused the physicians to devote themselves to the search for chemical remedies, and thus to gain an increasing knowledge of practical chemistry. At this time, of course, there was no recognized science of chemistry. There were no chemists. The physicians, many of whom became intensely interested in chemical matters, composed almost the only group which devoted itself to chemical subjects.

These men had, however, certain traits which resembled those of the Greek philosophers. They often preferred speculation to actual experiment. Although the idea of a test of theory by experience gradually became more widespread, the medical profession was not the group from which a union of theoretical and practical chemistry could be generally expected. Instead, in the seventeenth century, two new groups with strong chemical interests appeared. They tended to be divided geographically, one group being predominant in England, the other on the Continent.

In England, the important scientists were the amateurs. Boyle is the most prominent example, but there were many others, gentlemen of sufficient means to devote themselves to whatever most interested them. Out of their meetings grew the Royal Society, and this in turn stimulated them to fresh efforts to unravel by experiment and explain by theory the problems of the natural

world. Science, including chemistry, became in England the preserve of the amateur.

On the Continent another group took the lead in establishing chemistry as a science. It was composed of the pharmacists. Their profession was an important one; they were well educated and respected, and they worked with chemical substances and chemical apparatus in their pharmacies as physicians never did in their practice. Like the earliest alchemists in Alexandria, they knew the theories and they observed the facts. Their observations in turn suggested new theories. No invading mysticism wiped out the practical results of their work. Such men as the two Rouelles, E. Fr. Goeffroy, N. Lemery, Scheele, and Klaproth were chemists in every sense of the word, though they were primarily pharmacists. In the eighteenth century, many of the prominent chemists on the Continent had had training as a pharmacist⁷.

At the end of the century, therefore, conditions were ripe for the union of chemical theory and chemical practice on a scale previously unknown. When Lavoisier, one of the few French chemists who fitted more nearly into the English tradition of the amateur, finally overthrew the doctrine of phlogiston and established chemistry essentially on its modern basis, the final step had been taken which would make possible a great chemical industry.

In order to establish such an industry, attention had first to be concentrated on obtaining on a large scale the basic chemicals from which more complex substances could be prepared and more complex processes carried out. The manufacture of relatively simple materials, such as glass, leather, and metals, as well as the extraction of herbs and the preparation of medicines existed at the end of the eighteenth century only on a small, local scale. Most of the materials were produced at a site where some at least of the raw substances required already occurred, and most filled only local needs. A few essentials, such as barilla, the ash of plants used as a source of soda, usually had to be imported.

With the Napoleonic era such small scale production no longer filled the needs of the time. To support the vast armies and the continent-wide operations of the French military system, production of all kinds had to be increased greatly. The British blockade made it necessary to meet these requirements by internal

manufacture rather than by importations. Fortunately for the French, world leadership in chemistry rested with them. The impetus to chemical research given by Lavoisier was continued by a brilliant circle of chemists. They were mostly men of an academic background, but they possessed a versatility which allowed them to study both theoretical and practical problems with very successful results. The needs of France were met by such developments as the Leblanc process for the manufacture of soda, the beet sugar industry founded by Macquer on the basis of the discovery by the German pharmacist Marggraff of the presence of sugar in beets, the use of chlorine in bleaching, as developed by Berthollet about forty years after the discovery of chlorine by the Swedish pharmacist, Scheele, and the improvements in sulfuric acid manufacture suggested by Gay-Lussac. As a result of such discoveries, the profession of chemistry became recognized in its own right. The large scale manufacturing chemist emerged from the ranks of the localized small factories and from the many pharmacists who had supplied the demand for chemicals and drugs from their own laboratories.

During the early part of the nineteenth century, the production of the basic raw materials of chemical industry thus expanded rapidly. Acids, especially that most important acid, sulfuric, alkalis, and salts were manufactured on a large scale. The expansion was confined entirely to inorganic substances, since the vast world of organic compounds was still regarded as a confused jungle by most chemists of the time. Before it could be entered, the inorganic substance needed as tools had to be supplied, and it was this lack which was now being remedied.

For a time, most professional chemists continued to be found in the universities. This was inevitable, for training must precede practice, and at that period there were not enough chemists to supply an industry of any great size. The theories, the methods, and the apparatus developed by these men were as often applied by them to practical problems as to theoretical ones. The distinction between pure and applied chemistry scarcely existed in their minds, and as a result, progress in many directions was rapid.

The leading position held by French chemistry was gradually lost as the nineteenth century advanced. This was due in large

part to the extreme centralization of French science. All research centers, all training facilities of any importance were located in Paris. There the Academy of Sciences held undisputed control over scientific advancement. Anyone high in the councils of the Academy was assured of holding a considerable number of the most important positions in his field. J. B. A. Dumas⁸ was a very able organic chemist, but it was rather his influential position in the Academy which gave him the power of professional life and death over his colleagues. His enmity forced the brilliant and original Laurent and Gerhardt to struggle unsuccessfully throughout their careers for even the right to a satisfactory laboratory in which to work. The individual in France might devise processes of the greatest industrial value, but the conservative views of the dominant scientists prevented the founding of schools in which young chemists could be trained to exploit these discoveries. This explains, for example, why the methods worked out by Henri Sainte-Claire Deville for the manufacture of many important metals were developed industrially almost entirely in countries other than France.

In England, as the century advanced, the industrial revolution swept the country to new heights of prosperity. This, however, was a mechanical revolution. Steam power ran the machines which processed raw materials into finished products, and the chemistry involved in the manufacture of textiles and iron ware was slight. This was not because chemical problems did not exist in these fields, but rather because the manufacturers had no conception of the improvements which chemical research could make in their products. The English view of chemistry was responsible for this.

The English chemists, no longer amateurs in the tradition of Cavendish and Priestley, were still marked individualists. Davy, Faraday, Graham taught chemistry, but they founded no schools for training the great body of chemists required to support a chemical industry. In their private researches, they pursued their own ways. While on the continent, the subject of organic chemistry occupied the minds of nearly all chemists, the Englishmen followed their own interests and laid the foundations of branches of the science which did not develop their theoretical or industrial possibilities until the end of the century. The work of Faraday in

electrochemistry, or of Graham on colloids could not be fully appreciated in its own day.

Thus it was that the development of a chemical industry in England came not from the chemical profession, but of necessity from the engineers and industrialists themselves. The requirements of the iron masters who supplied the world with rails, ships, and machinery dictated that the metallurgical phases of chemistry should receive the greatest industrial attention. The invention of the Bessemer process in 1855 and the development of the open hearth process from 1863 illustrate the trends in the application of chemistry to industry in England⁹. These processes did not, however, demand the services of highly trained chemists, as did the organic industries which developed elsewhere. Medicinal chemistry was therefore a neglected field in England.

It was in Germany that a combination of factors brought about the rise of a chemical industry of the first magnitude, and one in which pharmaceutical chemists took a leading part. The German universities were decentralized. No one body dominated German science as the Paris Academy dominated French. Different approaches to chemical research and teaching could be, and were, tried in the various universities. It was at Giessen from 1824 that Justus Liebig set the pattern which made possible much of the future greatness of German chemical industry. By establishing the first effective teaching laboratory in chemistry, Liebig brought about the most complete union of theoretical and applied chemistry that had yet appeared⁶.

Prior to his time, most of the teaching of chemistry had taken the form of lectures and demonstrations by the professor. A few chosen individuals might be admitted to the private laboratory of the professor, but only as a personal favor, and only in numbers sufficient to provide for the professors of the next generation. Very few men had actual experience in chemical operations.

Under the Liebig system, the laboratory was open to all students. Not only were they taught chemical manipulations, but they were also given chemical problems to solve which required the application of the ideas which had hitherto been taught only as abstract speculations. All students of chemistry could now

receive the training which had been available only to the pharmacists in the previous century.

This system was quickly taken up throughout all Germany. It provided a supply of qualified chemists far too great to be absorbed by the universities themselves. Yet the interest and enthusiasm aroused by such master teachers as Liebig, Wöhler, or Bunsen was bound to find an outlet. The preoccupation of continental chemists with organic chemistry supplied such an outlet; quite different from that which has been described for England. The importance of many natural products as drugs, dyes, or perfumes was well known, and much attention was devoted to attempts to solve the problem of their structures. Most of these natural products were very complex, and the basic theories and methods of organic chemistry had to be worked out before such substances could be prepared artificially. In the course of developing these theories and methods, a task which occupied the time and energy of a constantly increasing number of students, a large number of new compounds were prepared. Inevitably, some of these also had practical uses. Thus, by 1860, when the work of Kekulé completed the basic theory of organic chemistry, there existed an almost limitless number of possible problems, the solution of any one of which might lead to results of the greatest value. For example, in the field of synthetic drugs, H. Kolbe's synthesis of salicylic acid in 1874, followed by L. Knorr's manufacture of the first synthetic antipyretic in 1883, opened a field which for decades was almost monopolized by German chemical industry.

The new generation of German chemists was fully prepared to exploit the new possibilities of organic chemistry. Before the more complex drugs or dyes could be prepared, however, it was necessary to have a large number of organic intermediates, themselves substances which did not exist in nature. Large industries grew up to supply these intermediates, which were never seen by the final consumers. When the intermediates were prepared usually with the intention of synthesizing from them some specific complex compound, it often became clear that they could also be utilized in the preparation of some previously unsuspected substance of great medicinal or commercial value. Therefore the chemical industries established large research laboratories to find new uses for their

products. Such laboratories employed not only chemists, but physiologists, bacteriologists, and other representatives of the life sciences. The science of pharmacology owes its existence in part to these laboratories. University professors acted as consultants for such laboratories, and so knew the directions in which their students could most profitably be guided in their own researches.

As the public became aware of the new drugs and other materials which were being supplied to them, even without a clear understanding of how these substances were obtained, the reputation of science began to grow. The number of students attracted to the sciences increased, and this permitted specialization to a still higher degree. Branches such as pharmaceutical chemistry became sciences in their own right. There is little doubt that the vast chemical industry which had developed in Germany by the beginning of the twentieth century was one of the most important influences in acquainting the general public with the importance of science. That it sometimes gave a distorted view of the real value and functions of science is a factor of considerable social significance.

The virtual monopoly of the fine chemical industry which was established in Germany drew to that country students from all over the world. The German universities became recognized centers of chemical training. Other nations made no attempt to establish such chemical industries of their own, but they did build up a reservoir of trained chemists. As a result, when the first world war shut off the supply of German chemicals, it was not impossible for them to develop their own industries. In connection with the occasion for which this paper has been prepared, it is of special interest that this need was felt most strongly and was met with particular success in the field of synthetic drugs. Arsphenamine and its modifications, for instance, before the advent of penicillin the most important weapons in the fight against syphilis, were then "in spite of the technical complexity of the problems to be dealt with", prepared for the first time in the United States¹⁰.

With the diffusion of chemical industry which thus came about, and with the violent nationalisms which were created in the

following years, every leading country of the world is now frantically attempting to surpass the activities of other countries in the production of chemical products, beneficial or otherwise. The number of new and important substances which have thus become available is great, but a new danger has arisen. The vital factor in chemical progress may once again be disregarded. The union of theoretical and applied chemistry, which has led to the greatest advances throughout the history of the science, requires that basic research be carried on continuously, and that its results be made freely known to theoretical and applied scientists everywhere. At present, nationalism and secrecy in science, as well as the urge to surpass all others in immediate practical results, threaten this union. It is difficult to see how this can be entirely avoided under present world conditions, but at least we must be aware of the trend and its probable consequences in reduced efficiency and slower progress. For a time, it will be possible to coast on the momentum of the past, and perhaps even seem to make greater progress than ever, but eventually, unless the world situation becomes more favorable, there will be a severe loss, not only to chemistry, but to science as a whole.

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The Development of the Microscope and Its Application to Medicine and Public Health

ABBOTT PAYSON USHER

Professor Emeritus of Harvard University; author of
"A History of Mechanical Inventions"

The development of medicine and the biological sciences has been so largely dominated by the use of microscopes for the past two hundred years that the present paper will be devoted exclusively to the description of the relation between the history of this technique of observation and the history of the sciences important to medicine. Many outstanding advances in science have been directly dependent upon new techniques of observation, and among the techniques important to science since 1600 the developments of optical instruments have occupied a commanding position. The range of visual perception has been extended to the galaxies in the astronomical field and to filtrable viruses and molecules in the field of microscopic observation. These new powers of observation have furnished data which require profound revisions of the scientific concepts of earlier periods. Despite alleged discoveries of ancient lenses, we have every reason to feel completely confident in asserting that all visual observation in antiquity and in the middle ages was based upon direct observation with the eye; uncorrected for normal vision, corrected for far-sightedness after the thirteenth century. Corrections for near-sightedness followed at a long interval. The development of skill in making spectacles was important as a basis for the more important achievement of telescopes and microscopes, but the lens makers of the late middle ages and the Renaissance exerted no influence upon the development of the sciences.¹

Beginning in 1590, important advances were made in the field of optics; craftsmen made new lenses and produced single and compound microscopes, and compound telescopes. Keler, (1611) and Descartes, (1637); worked out the general patterns of the

¹ Disney, Alfred N. ed. *The Origin and Development of the Microscope*. The Royal Microscopical Society, London, 1928. pp. 1-65.

optical systems for both telescopes and microscopes and analyzed some of the crucial problems of spherical and chromatic aberration. For the critical years 1590 to 1621 there is not enough detailed description of the work accomplished to enable us to distinguish accurately the achievements of the craftsmen and scientists who were working on the problem. We have circumstantial statements attributing the first compound microscope to Hans Janssen about 1590. Later, about 1610, Hans and his son Zacharias made a compound telescope. Other accounts ascribe the compound telescope to John Laprey or Lippersheim, 1608, as an independent and prior invention. There are also near contemporary references to work by Jacob Adriaanszoon, sometimes called Metius of Alkmar, and to the possession of instruments by Cornelius Drebel.¹ All this work may have been stimulated by suggestions in the writings of Porta.

In 1866, a microscope and two telescopes were presented to the Museum of the Zeeland Scientific Society at Middleburg. They represent very early forms of these instruments, and some have identified them as the Janssen microscope of 1590, and a telescope of 1618. They are clearly of early date, but these identifications are not secure.¹ The microscope was capable of magnifying about three diameters when closed, but when drawn out to its full length it had a focal distance of 14 cm. and magnified 9 diameters.

The initial work on these instruments involved six or seven men; at least three of whom were lens makers, and three or four trained scientists. The critical years were not dominated by any single person. The episode is distinctive for two reasons: the potentialities of these new instruments were quickly perceived, but the realization of these potentialities required fully two centuries of further effort. The telescope was a useful and important instrument even in its early form, when its powers were low in comparison with later forms. This is the usual history of a new mechanism. **The microscope**, on the other hand, must have been a great disappointment. It promised much, but gave little satisfaction. It exerted little influence on scientific thought or practice for a long period. As we look back on the record today, the ex-

¹ Disney, *op. cit.*, 66-106.

² Disney, *op. cit.*, pp. 102-106.

planation is clear. The microscope did not yield decisively new observational data until the power of the instrument had been notably improved above anything achievable in the seventeenth century. Furthermore, the sciences affected by the new observations were less prepared than astronomy to accept new points of view.

In astronomy, the Ptolemaic system had already been subjected to devastating criticism by Copernicus. Kepler and Galileo were ready to make further revisions in astronomical concepts even without the aid of new techniques of observation. Galileo's observations with the telescope merely completed the rout in a battle that had already been won. The heresy trial was precipitated by the sudden realization that the new scientific ideas were a serious threat to the whole structure of orthodoxy. In the field of the biological sciences and medicine the revision of classical doctrines and concepts was just beginning.

The history of the microscope can be followed most readily if we survey briefly the full array of functions that the developed microscope must possess. Single microscopes consist of a single lens, or, if corrections are attempted, a single lens system, which operates as a single lens. Simple microscopes have a considerable range of magnification, but cannot serve conveniently for more than the lower ranges of the compound microscope. The compound microscope consists of two lenses, or two lens systems. In its early forms single lenses were used. Corrections for aberration required the use of compensating lenses so that the developed microscope had two lens systems. The optical systems of the microscope of the early seventeenth century fall into two types, the Dutch and the Keplerian. The Dutch System uses a concave lens for the ocular or eye piece, and a convex lens for the objective. The Keplerian type uses convex lenses for both ocular and objective. In the Dutch system, the ocular enlarges the cone of light coming from the objective, prior to the formation of an image. In the Keplerian system an image is fully formed by the objective, which is then magnified by the convex lens of the ocular. The Dutch system was the earlier. Kepler's system was a revision based upon a more comprehensive analysis of the optical problem. The Kepler system produces an inverted image, so that

if the position of the image is important an additional lens must be used. Kepler did not himself construct any microscope, but his scheme was used by Christopher Scheiner to produce the microscope described in his *Rosa Ursinae*, published between 1626 and 1630.¹ Kepler's system has greater potentialities for development and became the primary type of the compound microscope.

The early microscope made no provision for the illumination of the field in which the specimen was placed. In practice, the microscope or lens was held in such a position that the specimen would be placed in a strong but diffused light. Usually there was no provision for viewing specimens in the early compound microscope except by reflected light. The development of the usefulness of the microscope as an instrument of research required important provision for illumination. The developed microscope is supplied with a mirror, a system of lenses to concentrate light on the specimen, and apparatus designed to block the direct light so that the specimen is illuminated from the sides.

The importance of illumination is most vividly emphasized by the great increase in light required by high powers of magnification.

Magnifying Power	Foot Candles
50	16
100	20
300	50
600	80
1000	250
2000	1050

Diffuse daylight rarely affords intensities above 100 foot candles, so that artificial illumination is necessary for magnification above 500-600 diameters.

The problem of illumination is also affected by diffraction effects developed by the air spaces between the specimen and the objective lens. Some light is reflected from the surfaces of the slide, especially on the edges of the cone of light. The cross section of the effective cone is, thus, smaller than the cone directed towards the observation stage. The amount of light is thus de-

¹ Gage, Simon, Henry. *The Microscope*, Comstock Publishing Co., Ithaca, N. Y.: 1941 pp. 560-561.

creased. Furthermore, the character of the illumination of the specimen is changed, so that the resolution of objects in the field is diminished. The maximum resolving power of the light microscope is given by Brown as 0.6 microns for a dry system. With oil immersion, the resolving power can be increased to 0.2 microns.¹

The fully developed microscope requires an observation stage conveniently arranged for the examination of specimens by transmitted or by reflected light. These details, presented little difficulty when the microscope began to be used systematically for research. It is important also to have some means of measuring objects under examination. Scales can be used on the cover glass or in the eye piece. These features of the microscope present no serious problems of design.

The potentialities of microscopic analysis have been greatly increased since 1932 by the development of the electron microscope. Independent work in Germany, Belgium and Canada resulted in achievements which were taken up finally in the United States and carried to the commercial production of microscopes using beams of electrons instead of light. The beam of electrons can be condensed or focused by magnetic coils in ways that are analogous to the behavior of light passing through lenses. The analogies are substantial because electrons of different wave lengths react differently to magnetic fields, so that phenomena of aberration are presented. **The beam of electrons must be passed through a high vacuum so that the observations must take place in this vacuum.** High temperatures are created. The conditions of observations are, therefore, profoundly transformed, but the capabilities of the microscope are very great, and the special problems of observation can be overcome. The general system of the electron microscope follows the pattern of the light microscope used with a projective screen. The electronic effects become visible images only when thrown on a fluorescent screen or upon a photographic plate. The highest practical powers of the light microscope were reached at 2000 diameters, and at the point the best effects could be secured by using ultra-violet light and photographic recording. The electron microscope carries our practical powers of observation to 100,000 diameters, and possibly somewhat further. It gives

¹ Brown, *Optical Instruments*, p. 242.

us the means of making direct observations of the behavior of small molecules. The atoms remain beyond any range of vision that we can **expect even of the electron microscope.**

The various degrees of magnification necessary for the study of the different forms of organic and inorganic matter are put in tabular form by Zworykin to exhibit the boundaries of the fields of study appropriate to the light and electron microscopes. It is especially useful for the definition of the low, medium, and high powered light microscopes. We have here the basic boundaries of instrumental observation. This represents the total achievement in the field of microscopes since 1590, when Janssen made a compound microscope capable of magnifying 9 diameters.

TABLE I

Object to be investigated	Diameter of distinguishable objects Microns 1 micron = .000039"	Magnification necessary to distinguish objects Diameters	Means of observation
Ordinary objects	100	1	
Fine machine work	25-100	8	Eye
Flaws in jewels			Magnifying glass
Pond life	10-25	20	Low power compound light microscope
Fungi			Medium power compound light microscope
Bacteria	1-2	200	High power compound light microscope
Structure of Bacteria	0.25	800	High power compound light microscope
Large viruses	0.10	2,000	Electron microscope
Colloidal particles	0.05	4,000	Electron microscope
Small viruses	0.01	20,000	Electron microscope
Large molecules			Electron and X-ray diffraction
Small molecules	0.002	100,000	Spectroscopy
Atoms	0.0001	2,000,000	X-ray and electron scattering

It will be observed that bacteria are distinguishable on the boundary between the low power and the medium powered microscope, but their structures cannot be studied without the high powered light microscope. Scales of magnification in the texts on cytology and histology suggest that the medium powered microscope is necessary for basic work in those fields, with urgent need of higher powers at many critical points. We are, therefore, led to the conclusion that the low powered compound microscope was not an effective means of carrying out the fundamental research necessary to establish the concept of cellular structure in plants and animals, or to provide any basis whatsoever for a competent theory of bacterial and virus infections.

The catalogue of microscopes in the possession of the Royal Microscopical Society suggests 1750 as the approximate date line for any significant development of microscope capable of magnifying more than 200 diameters. The period dominated by the low power microscopes covers about a century and a half. The medium powered microscope was not achieved until more than a century after the publication of Descartes' treatise; the high powered microscope not until two centuries later.

We now know that these delays were due to the difficulties of illumination and to the problems created by spherical and chromatic aberration. These phenomena were recognized at an early date; in some measure by Kepler and Descartes, but the full extent of the difficulties became apparent only in the late seventeenth century. Newton came to the conclusion that the problem of aberration was utterly insoluble. He abandoned all hope for the refracting telescope and gave his attention to the reflecting telescope which was free of this defect. The problem was finally solved because it was discovered that the properties of different kinds of glass were less uniform than was presumed by Newton.

The phenomena of aberration are due to the fact that light waves are refracted in different degrees according to their wave lengths. Violet rays have a much shorter focal distance than the red rays, so that the image formed by a single lens is not formed at a single point. If there is no correction at all and the focal distance is short the image is formed in a short spectrum of colored light. This would be especially conspicuous at the edges of

the object. It interferes with the resolution of small objects by leaving the boundaries vague, and provides the additional distraction of colors. There is also aberration due to the surface of the lens. Rays passing through the lens at different distances from the center do not come to a common focus.

These problems of aberration seriously limit the development of the microscope as an optical system based on simple lenses. Magnifying power could be developed, but the images were not sharp enough to show details.

The ultimate correction of these aberrations turned upon the combination of lenses of different types of glass, notably the flint and crown glasses. With care in working out the designs corrections could be made for both chromatic and spherical aberrations. Early work corrected for two colors, red and violet. Later, it became possible to correct for three colors.

In England, the basis for a mature analysis of refraction was established by John Dolland. His work grew out of a paper by Euler concerned with Newton's proposals to correct for aberration by the use of lenses of glass and water. Dolland published a letter in 1752 criticizing Euler, but with the presumption of the accuracy of Newton's values for the refractive indices of glass and water. Hearing that Newton's values had been challenged by Klingensstierna, Dolland repeated the experiments with refraction in 1755 and demonstrated errors in Newton's work. Other experiments in 1757 revealed the possibility of achieving refraction without color by the use of combinations of crown and flint glass. This work was done with prisms, as the preparation of lenses involved additional problems. These principles were applied to the telescope and a patent was granted. This was subsequently held to be invalid because the discovery had been anticipated by C. M. Hall, though the results had not been published.¹ The primary activities of the Dollands were in the field of astronomical instruments, but a number of microscopes were made. The correction of the lenses of the microscope was not common until the nineteenth century.

These date lines enable us to understand the limitations of the microscope in the eighteenth century. The power of the micro-

¹ Dictionary of National Biography. Dolland, John, Vol. V.

scope was increased to cover most of the range now classed as the medium range. The microscope became a more elegant instrument. Magnification up to 500 diameters was achieved, but the resolving powers of eighteenth century microscope left much to be desired. These improvements were secured primarily through the development of the illuminating system. The use of transmitted light became common practice, mirrors were used to direct light toward the slides on the observation stage, and in the second half of the century condensing lenses were used to concentrate light upon the field of vision.

The full establishment of achromatic lenses was the culmination of much work by many men in several countries. Special enthusiasms lead many writers to stress particular personalities, but there is little justification for presenting these accomplishments as the work of any one man. Amici in Italy produced good achromatic lenses as early as 1812. In France, the conspicuous achievement of Chevalier was in 1820. In England, the Dolland's worked on achromatic lenses for two generations. Small priorities in dates cease to be of significance when the vital feature of the achievement is not the mere concept of correction, but the theoretical analysis of the merits of different systems, and the precise details of lens forms and qualities of glass. 1820 or even 1825, is probably a fair average date line for the establishment in the microscope of the primary features of achromatic corrections.¹ The earlier microscopes made on this system were barely within the limits of the high power microscope as now classified, but magnifying powers were soon extended well into the high power field.

II

In the field of the lower powers of magnification it must be remembered that the simple microscope was an important competitor of the compound microscopes, throughout the seventeenth and eighteenth centuries. All the Leeuwenhoek's observations were made with simple microscopes, and many observers used spherical beads of glass made by a simple technique of glass blowing. The arrangement of Leeuwenhoek's lenses for observation are frequently

¹ Cf. *Journal of the Royal Microscopical Society*, London, 1909, P. 658-660. Descriptions of 10 achromatic microscopes, 1777-1848, selected to be shown at the Society's exhibit at the Franco-British Exhibition.

reproduced. The object was impaled on a point, held in proper focus by screw adjustments. This apparatus was held up to some appropriate source of light. Infusions were observed in a glass tube of small diameter. An important form of the compound microscope was developed by Robert Hooke and used in his observations. This microscope is interesting because it reveals concern with the problem of illumination and with the arrangement of a convenient observation stage. There was no attachment for micrometric measurement, but Hooke used scales in association with his specimens and many of the drawings contain reference scales to show the magnitude of the enlargement. At a later date, the observation of infusoria, undertaken as result of correspondence with Leeuwenhoek, led Hooke to arrange to view drops of water on a glass slide illuminated from underneath with the light from a candle or a small reflection of the sun.¹

Published microscopic observations in the seventeenth century begin with the book of Athanasius Kircher, *Ars Magna Lucis et Umbræ*, 1646. There are a few illustrations, but it consists predominantly of text descriptions directed towards the general public, rather than towards scientific interests. Some of these materials were republished by Gaspar Schott in 1657. Peter Borelius in 1655 reported observation of a hundred specimens, again with a few illustrations. The effective beginning of scientific observation and drawings is to be found in the *Micrographia* of Robert Hooke, published in 1665. The actual achievement is more notable for the revelation of a technique of observation than for any specific observations, though the drawings of a specimen of cork are notable both for the technique and for the recorded observation. In order to see the structure, Hooke found it necessary to cut the cork in very thin slices, and to lay them on a piece of black paper. This revealed the cellular structure of the cork, and Hooke uses the word cell in his description of his observations. The drawings of the eyes of insects are also of considerable interest. Hooke discontinued his microscopical observations, perhaps because of eye strain, which is suggested though not explicitly stated, perhaps because of competing interests.

¹ Hooke, R., *Microscopium*, 1678 in to Gunther, R. T. *Early Science at Oxford*, Vol. VIII p. 307-308.

Important series of observations were reported to the Royal Society by Leeuwenhoek from Delft, by Marcello Malpighi, from Italy, and by Nehemiah Grew, the secretary of the Society. A book by Johannes F. Griendelius of Nurnberg, published in 1687 is cited in bibliographies, but copies are rare and there are few references to his work. There is also a notable contribution by Francisco Redi, published in Florence in 1684. Redi was concerned with parasites found in living animals. But of all these observers, Anthony van Leeuwenhoek was by far the most important, both for the amount of work and for the challenging character of his discoveries. Observations were begun before 1673 and continued until his death in 1723. His lenses were superior to any others made during his life time, and no other observer matched his energy or his resourcefulness. He was the first to observe the infusoria and bacteria; and though Ham recognized spermatozoa earlier than he, Leeuwenhoek's observations provided most of the early material for the study of spermatozoa. Many of his observations were first published as letters to the Royal Society, but two general works as well as two collections of letters were published and a collected edition of his work in six volumes was completed just before his death (1715-1722). The new edition of the Collected Letters, issued in Dutch and in English will constitute a fitting memorial to a great observer.

His work in the general fields of the structures of plants and animals quickly entered into the accepted body of scientific knowledge, whether wholly original or merely supplementary. The observations of bacteria, infusoria and spermatozoa carried him to the limits of his microscopes and raised problems that could not be answered definitely without more detailed observations. The work in these fields also created new problems because many established concepts in biology and medicine were in sharp conflict with the implications of the newly observed phenomena.

The discovery of spermatozoa precipitated a controversy over embryology and the process of fertilization that continued for more than a century. An important group of scientists saw in the sperm cells what they believed to be evidence of the complete preformation of the adult animal in the sperm cell and the foetus. Observers presented drawings of a preformed chick, alleged to have been seen

with a microscope in an egg. The most extraordinary positions were taken by reputable scientists, and imaginative observers reported the discovery of a preformed humanculus in the sperm. Some of the drawings presented arouse doubts of the honesty of the observers. Cole feels that the episode is a tragic instance of wasted effort. He is convinced that the microscopes were good enough to have made it possible to settle the points at issue within a short space of time, if only the observers could have approached the problems free from the bias of erroneous ideas.¹

It is tempting to presume that there should be no serious difficulty in appreciating the significance of discoveries like the three major discoveries of Leeuwenhoek and his contemporaries. But there were a great many steps to be taken before any adequate understanding of these new phenomena could be achieved. The significance of bacterial action in fermentation was bitterly contested by Liebig as late as 1858, and in 1878, at the time of his death Claude Bernard left a manuscript in which he proposed a series of experiments which he presumed would disclose fundamental errors of analysis in Pasteur's work. We are today convinced that Liebig was in error here on certain details as he was on many other important points, but he was a great scientist and was making important contributions in the general fields of inorganic and organic chemistry. It was unfortunate, that with all his talent, he had little awareness of biological processes. In early experiments with plants, he carefully prepared phosphorus in an insoluble form, so that none of the precious food shall be lost in the drainage solution.

These resistances to new ideas should not be thought of as evidence of inertia and stupidity. They are indicative of the magnitude of the difficulties to be overcome in the attainment of new knowledge. In all these matters we are constantly misled by the belief that advances in knowledge are achieved easily by the inspired thoughts of a few men of genius. Nothing could be further from the truth. We acquire new knowledge only by patient observation and tireless critical activity in building up sound interpretative syntheses. Acts of insight are an essential feature

¹ Cole, F. J. *Theories of Sexual Generation*. The Clarendon Press: Oxford, 1930. esp. pp. 1-15, 37-44.

of the process of achieving new knowledge, but acts of insight are very numerous, not rare unusual events. In many instances, too, a major act of insight suggests a new question rather than a final and decisive answer to a question.

The microscopic work of the late seventeenth century revealed in a startling way the inadequacies of contemporary knowledge of biology. Observation had been confined to superficial study of the grosser structures of plants and animals. Processes were not understood, and the interpretation of known data were obscured by intrusions of speculative philosophy and theology. At the beginning of the eighteenth century, this speculative thought was presented as a system or as an array of systems. The biological sciences that were gradually taking form were hardly more than loose aggregates of detached observations. There were few generalizations of any importance. The primary task of the eighteenth and early nineteenth centuries was to build a secure foundation for these new sciences and to achieve some primary generalizations. This was a slow and a laborious task, but it was a necessary task. Unless the resistances are ignored, it is difficult to feel that the rate of development was slow.

Whether it is a mere coincidence or a significant condition for further progress, the fact remains that basic generalizations in the biological sciences were made during the period in which the development of the high powered compound microscope was assured beyond all possible doubt. The foundations of modern cytology were laid by the work of Schleiden and Schwann in 1838 and 1839. Embryology was freed from the incubus of sterile controversies by the decisive work of Baer in 1828 on the processes of generation in mammals. Von Mohl in 1844 recognized the identity of the nitrogenous material in the cells of plants and animals and gave it the name "protoplasm". The cell became the underlying feature of the genesis, functioning and structure of all plants and animals. These concepts made it possible to see the world of the microscope as an integrated system. The relations between living organisms and inorganic matter were not so clear, but the work of Liebig had established the broader lines of inter-relationship.

These great generalizations represent the culmination of a period of observation based upon the medium powers of the microscope. Most of the primary work was done with microscopes not exceeding 500 diameters of magnification. Gleichen had a microscope of such power (1778), and the publications of Schwann were based on drawings made at 450 diameters. Single lenses were used by many, especially in the botanical field. Robert Brown did much of his work with a single lense at 1/32 inch focus, which would be rated at 320 diameters of magnification, and later Dolland made a lens for him of 1/70 inch, capable theoretically of 700 diameters.¹

Although there was abundant ground for a belief in an organic theory of infectious disease, there were no proofs. Justus von Liebig had powerful convictions in what may best be described as a chemical theory of disease. "The most meticulous study has not enabled us to discover either infusoria or other organic beings whose presence could explain the contagious nature of smallpox, plague, syphilis, scarlet fever, measles, typhoid fever, yellow fever, anthrax, or hydrophobia."² Liebig made the common mistake of presuming that analysis had reached final conclusions. At this time a younger scientist Henle, with more imagination, wrote in a different vein. He believed that minute organisms penetrate our bodies in various ways, and develop after longer or shorter periods of incubation. The spread of infections can be best explained by the concept of these organisms as living matter. The failure to discover these organisms, Henle attributed to the defects of the microscope, which was incapable of revealing them in the tissues because the micro-organisms had the same index of refraction as the tissues.

These shrewd judgments are important because they show a keen realization of the necessity of further refinements in microscopes and in the techniques of observation. It was also clear that the basic problem lay in the production of proofs that would convince all the unbelievers, laymen no less than professed scientists. The critical problems were focussed upon the phenomena of fermentation and putrescence. The competing theories fell into

¹ Oliver, F. W. ed. *Makers of British Botany*, Cambridge, England, 1913, pp. 199, 200.

² Cited: Metchnikoff, E. *Founders of Modern Science*, Walden Publications, New York, 1939, p. 25.

the two general classes: the chemical theory of Liebig, and the biological theories. The biological theories were loosely conceived, and presented important variants. There was no certain knowledge of the relation of micro-organisms to disease. Some were convinced that they caused the diseases, others were disposed to accept them as incidental phenomena produced by the disease. Old doctrines of spontaneous generation had taken on new significance, because the emergence of micro-organisms in solutions that had been boiled was presumed to afford positive evidence of spontaneous generation. Before the close of the seventeenth century Redi had demonstrated the contamination of solutions from the air, but the doctrine was still vigorous in the mid-nineteenth century. There were many questions to be answered, and even when some plausible answers could be given, no real proof could be furnished.

Louis Pasteur, Joseph Lister, and Robert Koch gave definite answers to all the basic questions in the interval between Pasteur's paper on lactic fermentation in 1857 and the year 1885. By the end of 1885, Pasteur had demonstrated his treatment of hydrophobia; Koch had carried his research so far that all the phenomena of putrescence were clearly shown to be due to bacterial infection.

The full history of the development of Pasteur's work is of great interest because it exhibits an orderly sequence that is highly significant for modern concepts of the process of innovation. In any brief reference to Pasteur's career this systematic progression is likely to be lost, and the achievements may well seem to be the result of isolated inspirations. But this was not the case. Early work with the structure of crystals suggested differences between inorganic and organic crystals that led him towards a position contrary to the views of Liebig, which were then enjoying great prestige both because of their novelty and their association with the development of organic chemistry. This early work resulted in the discovery of a process for transforming tartaric acid into paratartaric, for which Pasteur was awarded a prize by the Paris Pharmaceutical Society.¹

Further work on fermentation was stimulated by studies undertaken at the request of M. Bigo, a manufacturer of beet sugar

¹ Wood, Laura N. *Louis Pasteur*, Julian Messner, Inc., New York, 1948. pp. 33-40, 46-52, 56-62.

at Lille. The manufacturers and their chemists were puzzled by abnormalities in the process of fermentation which ruined the product. Cagniard-Latour presumed that the yeasts used reproduced by budding, and that their growth was related to the process of fermentation. Pasteur spent a great deal of time in studying samples of beet juice under the microscope. It appeared that yeasts which produced good sugar were round globules; that the sugar became poorer if the shape of the yeasts began to change, and that the sugar was utterly ruined if the yeasts became definitely elongated. The beet sugar problem was solved sufficiently for practical purposes by this knowledge. Pasteur, however, was determined to proceed with some fundamental research project. Lactic fermentation was finally selected, as it involved the most direct challenge to Liebig's theory. Liebig recognized the importance of yeast in alcoholic fermentation, though he did not think living yeast was essential. Pasteur was anxious to prove the presence of a living organism in lactic fermentation. By careful examination an organism was identified that seemed likely to be the essential factor in the process.

The development of pure cultures of the organism established its significance. These results were announced in a paper read before the Scientific Society at Lille, in August 1857. The results of these specific experiments were described, but they were expressed in a fully generalized form. On the basis of work with some alcoholic ferments, and the lactic acid ferment Pasteur made the broad generalization that every ferment is caused by its own specific organism. The generalization expressed Pasteur's personal convictions rather than positive proof, but the decision to state a general theory was made deliberately. The paper was intended to be a foundation for further work; a starting point for the development of a comprehensive analysis of the relation of micro-organisms to life.

A special feature of Pasteur's career was the painstaking effort to demonstrate proof of the positions taken to the Academy of Sciences and at times to the general public. The proposition that yeasts and other micro-organisms were carried in the air was sharply challenged by Pouchet in December, 1858. After a long drawn out controversy a test was finally arranged in June 1864.

Pasteur's proofs were accepted as definitive, although in fact some aspects of the problem were not properly covered. Later, in 1878, the notes left by Claude Bernard raised the question once again. Pasteur built protective glass houses around a number of grape vines at Arbois while the grapes were still green. These vines were fully protected from the outside air until after the ripening of the grapes, on the theory that the yeasts were present in the atmosphere only at the time of the harvest. Bunches of protected and unprotected grapes were carried carefully to Paris for a demonstration before the Academy. On another occasion, the immunity of hens from anthrax was demonstrated by presenting to the Academy hens free from anthrax, and hens infected with anthrax. The latter had been cooled down in a water bath to reduce the body temperature to limits consistent with the development of anthrax.¹

After the announcement of a vaccine treatment for anthrax, Pasteur was challenged to give a demonstration by the editor of a veterinary journal, who offered sixty sheep for a test. Twenty-five were to be vaccinated; twenty-five were to be infected with anthrax without vaccination; ten were to be kept as a control. The test at Pouilly le Fort near Melun was carried out in an atmosphere of ill concealed hostility and skepticism. There were implications of possible bad faith on the part of Pasteur in making the inoculations. The conflict of opinion could not have been more sharply dramatized. There were anxious moments during the period of the test, because some of the vaccinated sheep were definitely sick the day after they had been infected with anthrax bacteria, but they recovered. All the unvaccinated sheep died.²

Pasteur's work was largely confined to studies of the ferments, various specific bacterial infections, and the techniques of preparing attenuated bacterial cultures to be used as vaccines for the control of infections. This work opened up important developments in medicine, but it left untouched the large field of putrefaction and suppuration. Some of the problems were involved incidentally in the work on anthrax, but the analysis was not developed at length. The major work in this broad field was done by Sir Joseph Lister and Robert Koch.

¹ Wood, *op. cit.*, pp. 137-8.

² Wood, *op. cit.*, pp. 151-157.

The new surgical methods suggested by the work in bacteriology were developed by Sir Joseph Lister beginning in 1865. Papers in the *Lancet* in 1867 and subsequent years gave the new procedures full publicity and laid a secure foundation for further extensions of both anti-septic and aseptic methods. But there was little new basic scientific study involved in Lister's practices. The necessary extensions of bacteriology were supplied by Koch in the seventies, after he had settled in Wollstein as the Health Officer.

The earlier work was occupied with anthrax, partly because of its great importance, but partly because the bacteria of anthrax could be conveniently studied with the microscopes then available. In this work Koch was attentive to all the details of the problems of observation, and though much had been done on anthrax by Pasteur and others Koch was able to supply new details of the life history of the bacteria that had been imperfectly worked out by the earlier observers.

The commanding achievements of Koch, however, began with his study of the infections in wounds.¹ The paper surveys the development of both experimental and microscopic work in considerable detail. There is also a careful description of the new techniques of investigation. The full record of these years well repays extensive analysis as a critical episode in the history of research methods and scientific generalization. But even the simpler features of the record are impressive

Koch points out that the experimental and empirical work up to 1877 establish a strong presumption of the bacterial origin of infectious diseases, but the achieved results were incomplete and inconclusive. Two primary sources of doubt existed. Some observers found bacteria in the blood of healthy animals and men. In many instances, it proved to be difficult to find bacteria in the blood of infected animals. Koch finally came to the conclusion that both of these doubts were due to defective techniques of observation. In healthy blood, the granular constituents could be confused with micrococci. In blood poisoning, the bacteria were

¹ Koch, R. *Untersuchungen über die Aetiologie der Wundinfektionskrankheiten*. Leipzig, 1878. Translated in Metchnikoff, Elie. *Founders of Modern Medicine*. Walden Publications, New York, 1939. pp. 153-233. Additional detail on the research work is to be found in the correspondence of the period which is used at length by Heymann, Bruno. *Robert Koch*, Akademische Verlagsgesellschaft, Leipzig, 1932. pp. 228-292.

so small that they could not be distinguished without the improved microscopes which became available at this time.

The new techniques involved the use of aniline dyes as staining agents, and the improvements of the microscope made by Abbe. The acid stains used up to this time were harsh and likely to injure the structure of many of the micro-organisms. But the use of Abbe's condenser, oil-immersion, and dark field illumination were indispensable. When this apparatus was used "the situation was completely changed. Preparations in which previously it was impossible to distinguish any bacteria at all or only bacteria with poorly defined characteristics, now surprisingly revealed the smallest bacteria with such clarity and sharpness of definition that they could easily be recognized and distinguished from the other colored objects in the preparation. But this method of observation yielded even more results. It was not only possible to perceive bacteria isolated and scattered among the tissues; but, what was even more important, the size and forms of bacteria embedded in the tissues could be observed with such accuracy that there was no difficulty in distinguishing according to size and shape pathogenic bacteria that could previously be recognized only as belonging to the large class of micrococci."¹

With these new techniques of observation Koch was able to establish two facts: That bacteria do not occur in the blood or tissues of the healthy living body either of man or of the lower animals; that the presence of bacteria can be proven for the group of traumatic infectious diseases. This notable paper, thus, provided a sound foundation for the best current practice in the treatment of infections, and established techniques for further analysis.

Later work on particular infectious diseases was not carried through to such decisive conclusions. The vibrio which causes Asiatic cholera was identified, and also the bacillus of tuberculosis. The effort to prepare a vaccine for tuberculosis was not successful, though Koch at first presumed that his tuberculin would cure all forms of the disease. It was most unfortunate that he did not at that time check his work with other observers as carefully as he

¹ Heymann, *op. cit.*, pp. 247-248.

had in the earlier periods when working on anthrax and on the general analysis of infection. Studies of the Rinderpest (1896), the bubonic plague (1897), malaria, and sleeping sickness contributed much to the development of medicine, but final results were not achieved.

In the course of work on bacteria, it soon became evident that another primary class of micro-organisms was responsible for infections of animals and plants. Many of these viruses were so small that they would pass through the pores of a porcelain filter. Viruses were recognized to be the cause of influenza, polyomyelitis, the common colds, and a variety of plant diseases. Early work on these diseases was hampered by difficulties of observation. The electron microscope now opens up this entire field to direct observation. The possibility of seeing these organisms does not itself provide solutions to all the biological and medical questions involved, but it marks one more advance in the range of scientific analysis. We now have the means of observing all forms of living matter, and we can explore with direct observations some of the boundaries between living matter and the larger molecules that seem to constitute the border line between living matter and the classes of materials that are not endowed with life. There is little prospect that any mode of perception akin to sight can be carried much farther, although spectroscopic analysis is a derivative from light. Since 1590, our powers of visual perception have been extended from the limits of the unaided eye to a point well beyond the boundaries of life in any form.

From Empirism to Applied Science in Pharmaco-Botany

With some Remarks on the Need for
Institutions for Certain Branches of the History of Science

FRANS VERDOORN

Managing Editor, *Chronica Botanica*

Before we shall consider the development from empiric to applied pharmaco-botany it seems well to inquire about the meaning of "empirism" and "applied science".

Empiric, derived from the Greek *en* and *peira* (trial), is a relatively new term, it was first used in the 1540's to designate ancient, as well as 16th century physicians who based their practice on experience without bothering to acquire sound, basic anatomical and physiological knowledge. Later, the term was used to indicate any method relying on observation and experiment without the necessary scientific knowledge. Soon quacks and charlatans were called empirics. Since 1813, the term has been used, in a modified sense, for a school of philosophy, and today the word is used, mainly in a figurative manner, to indicate results obtained by simple observation.

It is not so simple to trace the history of what we call "applied science". Each branch of the natural sciences develops through cycles and, though applied science is never a main component of such cycles, we note that there are, in the development of each science, from the primitive to the more developed stadia, certain periods when the results of new knowledge are being applied in a strikingly successful manner to the improvement or complication of mankind's fate. In pharmaco-botany the discovery of new plants yielded useful new drugs whenever new regions became known. Generally speaking, it was, however, not until the 18th century that new knowledge in the plant sciences found useful application in agriculture, horticulture, and forestry. The evolution of applied science, "useful knowledge" as it was then called, goes back to such pioneers as Tull in England, Duhamel du Monceau in France and Thaer in Germany, though there were, of course, many forerunners. We should also remember that many of the scientific societies and academies of the 18th century were chiefly initiated as societies for the promotion of useful knowledge, to promote horticulture, agriculture, and plant technology according to the naturalists' new findings. But, just as it is not sound to distinguish between national and international science, or between popular and scientific biology, we cannot distinguish sharply between pure and applied science. The two are so closely inter-related in their development and in their methods that the best of us have always considered a sharp distinction between pure and applied science artificial and undesirable. Also, as Wilhelm von Humboldt remarked: "Die Wissenschaft gießt oft dann ihren

reichsten Segen ueber das Leben aus, wenn sie sich von demselben gleichsam zu entfernen scheint".

Cycles in the development of natural sciences.—If we analyze the development of the plant sciences, or any other branch of the natural sciences, we find cycles of development resulting from three approaches, or we may say, from the endeavours of three types of investigators (each of whom may be a man of theory or a man of practice) :—

- 1) **The empirics** who base their views and practice on simple observations and experiments without wasting time studying the basic principles and laws of nature, such as the anatomy, morphology and physiology of plants, animals and man. The result is a miscellany of great advances and glaring errors, nevertheless the basis for most scientific knowledge. Those, working according to the empiric method, have often been subject to superstitions with which the historians of pharmaco-botany are only too familiar. We may mention the magic rites of the medicine men of primitive races, the doctrine of signatures of the early herbalists, the astrological speculations of some later herbalists and, in modern times, the annoying mixtures of facts and fancy of the "organic" herb growers.
- 2) **The pioneers** to whom we owe most basic knowledge of the structure and function of organic and anorganic nature, who have shown how to conduct and interpret experiments, how to describe, classify and analyze the endless diversity of nature. In the natural sciences we recognize three main types of pioneers: the taxonomists, concerned with the description and classification of plants and animals—the anatomists and morphologists, concerned with the structure of organisms—and the physiologists, concerned with the function of organic bodies.
- 3) **The traditionalists** who, while relying mainly on the observations and interpretations of others, add, within this framework, to our knowledge of pure and applied taxonomy, morphology, and physiology.

It is easy but not entirely correct to say that the history of early pharmaco-botany was a time of empirism, with a few pioneers such as Aristoteles and Theophrastus, that the Middle Ages were a period of traditionalism followed by empirics and pioneering in the Renaissance and that modern time again is a period of pioneering. In each man of science, ancient, mediaeval, or modern, is something of the empirist, a little of the pioneer, and much of the traditionalist. Just as this trinity exists in each of us,

it exists in each of the major periods of human endeavour and it is the attractive task of the historian of science to show the role and the interaction of these approaches and the resulting cycles through the ages.

The development of the herbal and phytopharmacy offers us one of the nicest illustrations, not only in the history of pharmacobotany, but also in the history of science in general, of the trinity of empirism, pioneering and traditionalism. The earliest herbals, whether of the Greeks, the Arabs, the Chinese, or the Aztecs are mainly empiric but elements of pioneering are met with in Theophrastus and Dioscorides and to a lesser extent in Avicenna, the Mexican codices, and the early *Pen Tsa'os*. In Apuleius, *Circa Instans*, and the *Ortus Sanitatis* we meet with new empiric data combined with an enormous amount of traditionalism. Pioneering efforts dominate in herbals of Clusius, Gessner, Bock, Fuchs, Brunfels, Ruellius, Cordus and Johnson, to be followed again by the more traditionalist writings of Lonicerus, Zwinger, Tabernaemontanus and Thurneysser. It is, of course, impossible to sketch the development of the herbal in a few words and dangerous to generalize it. The fascinating period of the herbalists, too often studied chiefly from a bibliographic or taxonomic point of view, in the eighteenth century, gave us the beginnings of modern botany and modern phytopharmacy.

Phytochemistry, with which you all are only too familiar, also shows an interesting cycle of growth. It was first developed by pharmacists as Neumann, Lemery, Geoffroy, Scheele and especially Hermbstaedt, whose "Anleitung zur chemischen Zergliederung der Vegetabilien" should be mentioned in this bird's eye view. Then, men as Flueckiger and Tschirch, worked out a classification of drugs according to chemical constituents after which Wasicky gave us his chemical-pharmacodynamic classification of drugs.

The development of organic chemistry is another period in the history of science which offers not only many nice illustrations of the trinity of empirism, pioneering and traditionalism in the 18th, 19th, and early 20th century, but more striking examples of the interaction of pure and applied science than perhaps any other chapter in the history of the natural sciences. In his recent auto-

biography, "Aus meinem Leben", Willstaetter gives a dramatic picture how within a few generations many of the unstable simples of the herbalists were replaced by synthetic products and how pharmacognosy became as much a chemist's as a botanist's territory, to the advantage of mankind's sufferings, as well as in the interest of organic chemistry, physiology and many related disciplines. On the other hand, the Flora Phanerogamica as well as the Flora Cryptogamica continue to supply phytopharmacy with many of its most effective products, new helpful alkaloids and steroids have been discovered recently in many flowering plants while the microbiologists have given us many antibiotics which open an unexpected, new era in medicine.

* * *

You may consider much of what has been said as a primitive effort towards a philosophy of the history of the natural sciences, or at most as a working hypothesis towards an understanding of ourselves and especially our historical heritage. In our time, when science and technology are developing according to a logarithmic curve, there seems to be less and less opportunity to see and understand ourselves as merely small links in a long chain which goes back for more than twenty centuries.

It is, in some ways, a sound characteristic of any period of pioneering to forget about the past. On the other hand, as natural scientists, we also know that to understand any organism we have to know quite a little about its history. You would not be here, today, to honor the memory of Dr. Kremers, and to compliment Dr. Uhl the founder of the Institute of the History of Pharmacy, and its energetic Director, Dr. Urdang, on the results of ten years' work, were it not that you were convinced of the importance of the history of science and the study of the history of the branch of science you represent. To plead with you for the history of science would be carrying hyssop to Jerusalem.

With your permission, I should, however, like to use the opportunity offered by this meeting to give now some thought to a brief consideration of the need for and the organization of institutions for the history of special branches of science, institutions of the type as this splendid institute for the history of pharmacy,

the tenth anniversary of the establishment of which we are now celebrating.

On Institutions for certain branches of the History of Science:—

There exist at present several institutions for the history of science in general and many institutions devoted to the history of medicine, some of which concern themselves also with certain aspects of the history of pharmacy. Then, we have a few institutions devoted to the history of pharmacy, as well as a number of institutions for the history of chemistry. Other branches of the natural sciences practically have no institutions devoted to their history. In my own fields, biology, agronomy, and kindred subjects, we find that there exist at present, throughout the world, about ten thousand institutions and departments, concerned with agronomy, botany, entomology, horticulture, zoology, and related subjects, but not a single institution devoted to the history of biology and agriculture, or even some institute for the history of science primarily concerned with the history of biology and agriculture. There are a few professors for the history of agriculture in the larger agricultural colleges but they are, as a rule, concerned with economic rather than with the technical and biological aspects, there are also a few outstanding professors for theoretical biology, as van der Klaauw and Meyer-Abich, who concern themselves, of course, much, though not primarily, with the history of biology.

There is, however, a worldwide revival of interest in the history of biology and agriculture and many colleagues share the view which I outlined, during the past decade, in a number of papers,* about the need for more serious and properly organized and co-ordinated work along these lines.

Huxley, Needham, Sigerist and others have shown that, in addition to academic research in the history of the natural sciences, there is a need and attractive possibilities for historical work combined with international relations work and with projects concerned with the cultural aspects of the pure and applied biological sciences. You, and others who share these views, will, without

*On the Aims and Methods of Biological History and Biography (*Chron. Bot.* 8, 4:425-448, 1944); Problems of Botanical Historiography (*Arch. Int. Hist. Sci.*, Num. 15:448-457, 1951).

doubt, agree that our aims cannot be accomplished unless we will have, before long, throughout the world, a number of institutions (or departments of existing institutions) devoted to these pursuits. In my own Alma Mater, the University of Utrecht, we have well organized institutions for the history of art, for the history of music, for mediaeval history, for modern history, for the history of law, as well as for the history of medicine. But, though courses are being offered in the history of certain of the natural sciences, there exists no workshops concerned with the history of any of the natural sciences, except medicine.

1) *Location*.—Even if such historical research units or workshops, as we are considering at present, would have considerable funds, it remains necessary that they will not be founded on an individual basis, that they will not operate as individual units, but that they will be established in close cooperation, on the one hand, with existing scientific institutions, and, in close cooperation, on the other hand, with the existing institutions concerned with the history of the humanities and the chairs for classic and oriental languages. Workshops for the history of science are always hybrids between institutions devoted to natural science and institutions devoted to the humanities!

The historical research unit we are considering can, therefore, be established only in the immediate neighborhood of the world's larger libraries.

2) *The programme of work* will have to be properly balanced between educational, research, and extension activities. To be effective, an institute for the history of biology and agriculture, to use this again as an example, will have to train young biologists and agronomists, who have the proper interest and the necessary background to become biological and agricultural historians. We must recognize that vocational training only in these fields can never be more than the first step in the development of a biological or agricultural historian, he needs his workshop, his institute, just as the physiologist needs his laboratory and the taxonomist his herbarium. The staff, students, and collaborators of the institute will naturally engage in biological and agricultural historical research. As we have seen, the staff may also be able

to play a more important role in the promotion of international scientific relations than specialized research workers.

3) *Library*.—No institute devoted to any branch of the natural sciences can be effective unless it has a sound working library on its own premises. Such a library of the chief literature, dealing with the history of the subject concerned, seems the first requisite for effective teaching and research. Some of the scientific historical research institutions will endeavor to collect the classics in their field, others may find that the classics are easily enough available in nearby college or institutional libraries. Yet, a representative collection of the great classics seems desirable for didactic purposes. It is well to remember, in this connection, that many classics may still be acquired today at a very reasonable price. A later generation may no longer find them as easily available! As to journals and serials, institutes must have complete sets of the leading journals dealing with the history of their science, but I feel that no great effort should be made to assemble other journals—this would be an endless task which would tie up too many funds and the journals needed will be easily enough available in the nearby libraries. Certain of the older serials (in botanical history, e.g., the *Gardener's Chronicle*, *Nature*, *Botanische Zeitung*, *Oken's Isis*, *Flora*, etc.), though at that time not particularly devoted to the history of science, contain, however, so much historical material and will have to be consulted so often that one will need complete sets of some of these by all means. Then, an institute for the history of science cannot operate properly unless it will have the leading encyclopaedias, particularly also the older encyclopaedias, biographical dictionaries and a number of other, often fairly expensive, biographic and other reference works on its own premises.

4) *Archives*.—The institutions we are considering, will, of course, build up card indices dealing with all published literature on their subject's history, bibliography, collective biography, etc. An index of data on early centers of learning, concerned with the subject, geographically arranged, will also be useful. Then, one will want to build up vertical filing systems with manuscripts of various kinds, letters, autographs, portraits, historical, bibliograph-

ical and biographical reprints, early maps, early prints of various types, etc. Only a few institutions, devoted to the history of science, will be able to obtain mediaeval manuscripts but photostats or microfilms of many codices are now becoming available.

5) *The minimum staff*, from which worthwhile results may be obtained should, I think, consist of a director with at least one associate of standing, one librarian-bibliographer, one office secretary, and one or two typists. The preparation of sound theses on the history of science often takes more time than other theses and some funds will have to be available for student assistance.

6) *Publications*.—The institutes we are considering might well begin with a journal or yearbook, to be supplemented, in due time, with a series of memoirs. Under certain circumstances a newsletter may be desirable. The institutes will want to publish their journals directly as they will serve to obtain about 300 current journals and serials concerned with the history of the natural sciences and medicine, in exchange, but the series of memoirs should, if possible, be handled through a publisher or a college press in order that the director and staff will not be burdened with the details involved in producing and marketing the fairly extensive and voluminous publications which any active Institute for the History of Science will turn out.

7) *Finances*.—An annual budget of \$30,000 will be the minimum from which worthwhile results may be expected under present conditions in the U. S. A. This means that the institute should either have a capital of about \$700,000 (a fairly large amount for such new ventures) or that all or part of its funds will have to come, on an annual basis, from other sources. Some of the members of the staff may be paid from university or museum or library funds, others from private donations, contributions from societies, and others again from foundation grants, such as Dr. Sarton's institute received from the Carnegie Foundation of Washington. Several of the large U. S. foundations claim to be particularly interested in research in the borderlands between science and the humanities and it may not be possible that formally organized institutions with a long range programme in certain branches of the history of science will be able to obtain more grants from

these foundations than individual research workers in our field have been able to obtain in the past.

8) *Museum*.—Though this may not seem necessary to some, I believe that any active and successful institute for the history of some branch of science will have to organize a public museum to show the development of its chosen field. In such a museum one may show (1) interesting old prints, (2) classic books, (3) early instruments used by previous generations, (4) specimens and preparations of various types, made by or used by previous generations, (5) portraits, (6) models or dioramas of early laboratories, institutions, gardens, etc. Modern dioramas cost much money but it is the opinio communis of most modern museum directors that any good diorama is a worthwhile investment.

9) *Gardens*.—Under certain circumstances institutions devoted to the history of agriculture, biology, horticulture, or pharmacy, will find it worthwhile to reconstruct certain gardens of the past on their grounds, on the campus, or in a nearby university botanical garden or local arboretum. I outlined the need for and the possibilities of the reconstruction of gardens of the past previously in detail. Whereas dioramas call for a considerable outlay, the construction of gardens of the past often does not cost too much, but experience has shown that the proper maintenance of historical gardens is often an expensive proposition. Projects of this type should, therefore, not be attempted unless there are sufficient funds or unless it is felt that more donations can be obtained by establishing and maintaining historical gardens!

* * *

Local conditions will determine whether one will establish an institute devoted to the history of an entire branch of science, for instance an institute devoted to the history of biology, or an institute devoted to a more limited field as, e.g., an institute for the history of zoology. Whatever type of institution one may establish, full attention will have to be given, in my opinion, to the applied aspects of the branch of science concerned. An institute which proposes to concern itself with the history of botany, must give full attention to the history of agronomy, horticulture, and forestry (exclusive of the economic aspects which are being studied

already adequately by others), an institute devoted to the history of zoology will have to give full attention to applied entomology, certain aspects of agriculture, hygiene, many aspects of medicine, etc.

* * *

To conclude, I want to emphasize again, with Julian Huxley and Joseph Needham, that there exist extremely close relations between work in the history of biology and the promotion of international relations in biology. As I wrote in my Annual Report for 1950 of the Botanical Secretariat of the International Union of Biological Sciences: "We cannot make the modern, highly specialized biologist, with his limited outlook, more internationally minded unless we stimulate research in and a better understanding of the untrodden borderlands between the humanities and the natural sciences". Also, we should never forget the close relations between the study of the philosophy and the study of the history of science.

I strongly feel that, to be effective, any institute for the history of a branch of science will have to follow the program developed by Sigerist for his Institute for the History of Medicine at Johns Hopkins University, which became the world's leading institute for the history of medicine, as the institute did not concern itself merely with the academic aspects of the history of medicine, but equally with the international, philosophical, social, and cultural aspects.

The Application of Science in Pharmacy

GEORGE URDANG

Professor of the History of Pharmacy, University of Wisconsin

The Beginnings

Pharmacy was born on European soil as a legally recognized profession of its own when, in 1240, an edict issued for the kingdom of the Two Sicilies by the German Emperor, Frederick II of Hohenstaufen, separated pharmacy from medicine.

It was a new profession of technicians, not of scientists that was created. "What was called science [in the field of drug therapy] at that time remained with the physicians, and it was little more than the knowledge of some mutilated remnants of antique wisdom and its employment within the definite boundaries of a rigid medical and therapeutic doctrine."¹ To quote from John Dewey's *Reconstruction in Philosophy*: "Men looked at the work of their own minds and thought they were seeing realities in nature."²

There were many, much too many drugs, both simple and compounded, in the apothecary shops of old up to the late seventeenth century. Still later, taken from the vegetable, animal or mineral kingdom, they were used either as nature offered them or, more often, in mixtures and preparations, as electuaries, syrups, wines, pills, troches, clysters, ointments, plasters and so forth comprising up to a hundred and more ingredients. Since these preparations were not very stable and there was no way of checking whether or not they really contained all the ingredients for which their formulas asked, every pharmacist had to be the manufacturer of the compounded drugs which he shelved and sold. Even the checking of the identity and adequate quality of the simple drugs, rested almost entirely on the empirical experience gained by the pharmacists in using the senses of sight, touch, taste and smell.

When about 1450 Saladin de Asculo, physician in ordinary to the prince of Tarentum, wrote his *Compendium Aromatariorum* especially designed to serve—in question and answer form—as a source of information as to the materia medica of the time and the professional activities expected of a pharmacist, he defined the task of the "aromatarius" as consisting of the preparation of medica-

¹ G. Urdang, *Pharmaceutical Education from the Historical Point of View*, *Am. J. Pharm. Educ.* 6: 53, 1942.

² John Dewey: *Reconstruction in Philosophy*, Mentor Books, New York 1950, p. 51.

ments by "rubbing, levigating, infusing, boiling, distilling, thoroughly compounding and taking good care of the preservation of the compounds."

As to the testing of the drugs we read in Saladin's *Compendium* that "it also behooves the apothecary to know and to recognize the taste and savor of all simple drugs, be they bitter or sweet, sharp or sour, astringent or musty, of pleasant flavor or not."

Distillation as a New Departure

To say it in the language of the Bible, the dry land of science had still not appeared although its spirit already "moved upon the face of the waters" (genesis, 1, 2 and 9). It was the burnt, the distilled waters on which this spirit moved.

"It seems", says R. J. Forbes in his *Short Story of the Art of Distillation*,³ "that the Muslim druggists were the initiators of this art [of preparing essential oils by distillation without, however, separating the oils from the distilled water] and that the West imitated them."⁴ Forbes then makes the following statements:

"The Middle Ages [from the eleventh to the thirteen centuries] bring the discovery of the mineral acids and alcohol. The former revolutionize chemistry because they make reactions in solution possible. The latter had a profound influence on the development of distillation apparatus and thence on laboratory technique and the art of the pharmaceutical chemist . . .⁵ It is certain that the medieval scientists understood the phenomenon of evaporation and condensation quite well and were thus aware of the principles underlying distillation."⁶ Forbes is of the opinion "that the apothecaries were the first to produce alcohol on a larger scale."⁷

Here then, in the process of distillation, there appeared not only another technique adding a new class of pharmaceutical products, the distillates, to those known since time immemorial, but a meeting of scientific phenomena by that particular sequence of experiment and consideration which is the criterion of what is called scientific research today.

Up to modern times pharmacists have played a great part in the development of the technique of distillation including the ap-

³ Leiden 1948.

⁴ *Ibidem*, p. 48.

⁵ *Ibidem*, p. 57.

⁶ *Ibidem*, p. 72.

⁷ *Ibidem*, p. 91.

paratus used, and finally in the clarification of the nature of the products gained. That has been stressed in Forbes' meritorious book again and again. Among a number of others who improved the distillation apparatus he mentions the German pharmacists J. W. Doebereiner (1780-1849), the man who for the first time made practical use of the principle of catalysis, and S. F. Hermbstädt (1760-1833), one of the most important chemical technologists of his time who created, in 1803, the term (if not even the concept) "agricultural chemistry". As to the nature of the products of distillation, especially of the volatile oils, tribute has to be paid to quite a number of French and German pharmacists, among them N. Lemery (1645-1715), A. Baumé (1728-1804), Kaspar Neumann (1683-1737) and J. Ch. Wiegand (1732-1800).⁸ Of American pharmacists there merit mention William Procter, Jr., the so-called father of American pharmacy (1817-1874), and Edward Kremers (1865-1941), who headed the School of Pharmacy at the University of Wisconsin for almost half a century.

That the process of distillation still plays an important part in the practice of pharmacy becomes obvious from the fact that the present day pharmacopoeias all over the world list distillates and employ distillation in some of the tests for identity and purity and that in some countries for instance in France and in Germany, a modern still and a reflux condenser⁹ belong to the legally required equipment of the laboratory of an apothecary shop.

The Concept of "True" Pharmacy as Identical with Chemistry

It was the process of distillation which ushered in the pharmaceutical laboratory and, in its gradual development, helped to develop technical skill and theoretical reasoning. When in the seventeenth century the speculative element in chemical endeavor gave way gradually to experimentation led by and leading to hypotheses but no longer enslaved by them, the new scientific chemistry found in the profession of pharmacy the place, the equipment, the men and the readiness necessary.¹⁰

"Distillation being a means of separating the essential from the crude and nonessential with the help of fire, it met in an al-

⁸ *Ibidem*, p. 7.

⁹ Invented by Chr. E. Weigel in 1771. The name "Liebig condenser" resulted from the advocacy of Weigel's apparatus by Liebig.

¹⁰ G. Urdang: *Pharmacy's Part in Society*, Madison, Wisc. 1946, p. 24.

most ideal way the definition of a 'chymical' process valid until about the end of the seventeenth century and given a special meaning by the great Swiss medical reformer, Bombastus Paracelsus von Hohenheim (1493-1541). His theory was that it is the last possible and most sublime extractive, the *Quinta essentia* (quintessence), which represents the efficient part of every drug, and that the isolation of this extractive should be the goal of pharmacy."¹¹ Supplementary to this concept was that of the specificity of such "quintessences" asking for the search of a particular drug for each particular disease.

It was this Paracelsist idea of the "essential", with its philosophical basis in Aristotelian concepts, and only to a small extent the actual findings of Paracelsus, which exerted so great and lasting an influence on drug therapy. The door was opened for the attempt at extracting the "essential" and its separation from the inert by chemical as well as by technico-physical processes. Furthermore, the introduction of chemicals for internal use into drug therapy made chemical knowledge and work a necessity for the pharmacist.

It was in 1660 that a book was published by a pharmacist for pharmacists claiming a kind of identity of pharmacy and chemistry and representing the most complete information about the chemical knowledge of the time in its application to pharmacy. Its author was the French apothecary N. Le Febure (1610-1669). After having taught chemistry at the Jardin du Roi at Paris, he emigrated to London where he became professor of chemistry to Charles II, apothecary in ordinary to the royal household and a fellow of the Royal Society. The French original was entitled *Traité de Chymie, theorique et pratique*¹² while the English translation of the book (London 1664) carried the title "A Compleat Body of Chemistry: . . . teaching the most exact preparation of *Animals, Vegetables and Minerals**, so as to preserve their essential Vertues. Laid open in two books and dedicated to all apothecaries & c." Le Febure exclaims that he is teaching "the *true** Pharmacy, which is Chymistry".

¹¹ G. Urdang, The Origin and Development of the Essential Oil Industry in E. Guenther: The Essential Oils, vol. I, New York 1948, p. 4.

¹² Le Febure's book was still reedited, in a French revised and augmented edition, in 1751. It has been considered by the renowned historian of chemistry, Hermann Kopp, as "especially instrumental in the promulgation of chemistry."

* All italics are in the original.

Referring to "the subtil Van Helmont" (1577-1644), to "the industrious Glauber" (1604-1670) and to Paracelsus as his masters, Le Febure makes the following statement:

"... First That Chymistry doth not merely consist in the skill of preparing well a Remedy, as many do erroneously imagine; but in the using of it with due circumstances, and respect to the Theorems of Art which is properly the true Physick: Secondly, that whosoever meddles with Chymical remedies, without the previous grounds of Theory can deserve no other name than of an *Empirick** ... These rare prescriptions of Chymistry, have their remedies grounded, not upon the actions of first and second qualities, but upon the specifical and internal vertues of their Chymical Principles ..."

This is a definite defiance of the stringent rules dominating the choice of drugs in Galen's humoral pathology as well as, above all, an enthusiastic expression of confidence in, to use another of Le Febure's definitions, chemistry as "*a practical and operative Science (or knowledge) of things natural*"*

Finally Le Febure addresses the apothecaries of England directly. "You will find, he says, the difference that there is in the *modus faciendi* of the *Ancient** Pharmacy with the *judicial, intelligent and reasonable government of the Chymical Artists, for the separation of the pure from the impure, and for the preservation of that which causes the efficacy and the vertues in things.*"

From now on until the early eighteenth century some kind of identification of "true" pharmacy with chemistry goes like the thread of Ariadne through the pharmaceutical literature. "Chemistry", we read in Antoine Baumé's *Elemens de Pharmacie Theorique et Pratique*,¹³ has gradually enlightened Pharmacie." Baumé describes "La Pharmacie Chymique" as the art which is designed "to define, by analysis, the nature and the properties of simple drugs and the effects of the one on the other in the mixtures of which they are a part. Chemistry enables us to avoid the mixing of certain substances which decompose each other."

In the last part of the eighteenth century the fact that the art of pharmacy is based not only on chemistry but, to quote from

¹³ Paris 1762.

¹⁴ Grundriss der Experimental Pharmacie, Berlin 1792.

* All italics are in the original.

S. F. Hermbstaedt's *Outlines of Experimental Pharmacy*¹⁵ "presupposes [the knowledge of] the most important fundamentals of several sciences," is given more emphasis again. Of such sciences Hermbstaedt mentions besides chemistry those of mineralogy, botany, zoology, physics and chemistry. To these basic sciences of pharmacy has been added another one that developed in the nineteenth century and is still gaining in importance: bacteriology.

Pharmacopoeias as Mirrors of Applied Science

This is not the place to list the great men who, coming from pharmacy, have graced their profession and have created for themselves a lasting place in the history of sciences, especially of chemistry. That has been done in the booklet, *Pharmacy's Part in Society*.¹⁵ But even in connection with the topic under consideration it is of interest that the Apothecary C. W. Scheele (1742-1786), one of the greatest chemists of all time, "had subjected to an exact investigation the entire material offered to a chemist in a pharmacy of his time"¹⁶ and that his method of isolating organic plant acids became a generally adopted pharmaceutical process. It is understood that the double capacity of many of these men as researchers on the one side and as recognized authorities with regard to the practice of pharmacy on the other made itself felt in the application of science in pharmacy as mirrored in the official pharmaceutical standards, called pharmacopoeias.

It was not until the late eighteenth century that the primitive, primarily sensual tests on identity and genuineness of the drugs listed in the pharmacopoeias were replaced by such resting on scientific considerations. In 1771 one of the most progressive pharmacopoeias of the time, that for the German State of Wurttemberg, introduced real chemical tests. But it was in the Prussian pharmacopoeia of 1799, a standard issued under the decisive influence of the pharmacist Martin H. Klaproth (1743-1817), discoverer of uranium and recognized as the greatest analytical chemist in Europe of his time, that wherever possible chemical tests were added to the monographs on drugs, serving the purpose of a sufficient and quick verification of identity and adequacy. This was a kind of forerunner to the abandonment of the legal obligation

¹⁵ G. Urdang, *Pharmacy's Part in Society*, Madison, Wisc., 1946.

¹⁶ *Ibidem*, p. 7.

of each Prussian pharmacist to prepare all the compounds, chemical or otherwise, for the manufacture of which the pharmacopoeia contained formulas. This happened in 1827, with the appearance of the fourth edition of the Prussian pharmacopoeia acknowledging the fact that by now pharmaceutico-chemical large scale industry had widely replaced the small-scale manufacturing by the individual retail pharmacist.¹⁷

In the United States it was in the Pharmacopoeia of 1842 (second revision) that chemical tests were introduced, although in a rather limited way. It was not until 1882 (sixth revision) that detailed tests for identity and purity and detailed processes for the assay of alkaloids appeared. In 1893 (seventh revision) assays for the determination of active principles in drugs and their galenic preparations and the use of optical rotation for physical characterization was introduced. In 1905 (eighth revision) a purity rubric for each chemical substance was made a matter of principle and in 1916 (ninth revision) biological tests or assays were included, chapters on diagnostic reagents, on sterilization and on refractive indices were added and several electrolytic determinations admitted. In 1926 (tenth revision) the first official vitamin A assay was published. As to the 1936 (eleventh revision) standard and its two supplements E. Fullerton Cook said that it "has brought order out of chaos for vitamins A and D and now for vitamin B1. . . . Practically all anti-anemia preparations from liver, now sold in this country, are evaluated and assigned their potency in terms of U.S.P. units, by the Pharmacopoeia."¹⁸

In 1942 (twelfth revision) there were adopted "approximately equivalent units of potency for those official substances for which Reference Standards have been established by the Permanent Commission of Biological Standardization of the Health Organization of the League of Nations" (now World Health Organization). While the 1947 U.S.P. (thirteenth revision) did not add any special feature to the testing armamentarium of the American pharmaceutical standard, the 1950 (fourteenth revision) book took an important step by replacing several biologic and animal assays by chemical ones. Vitamin A activity is now measured by a spectro-

¹⁷ G. Urdang, *Pharmaceutical Education from the Historical Point of View*, *Am. J. Pharm. Educ.*, 6: 57, 1941.

¹⁸ E. F. Cook: *The New Pharmacopoeia*, *Am. J. Pharm.* 111: 310, 1939.

photometric assay and for the cardiac glycosides a chemical-spectrophotometric assay has been introduced.

From the beginning of scientific chemistry the importance of the degree of the acid-base equilibrium was understood and attempts have been made at defining it. They lacked, however, a solid scientific basis until the establishment of the theory of ionization by S. Arrhenius in 1887. It was then that it was recognized that the extent to which an acid or base ionizes to form hydrogen or hydroxyl ions determines many of the properties of the substances concerned. It became customary to express the reaction of both acid and alkaline solutions in terms of hydrogen ion and it was on this basis that, in 1909, S. P. L. Sorensen proposed that hydrogen ion concentrations, i.e. the degrees of acidity or alkalinity, be expressed in terms of the logarithm of its reciprocal, assigning to this value the term pH.

This suggestion has found general acceptance and the convenient method of measurement which it offered, supported by the development of appropriate instrumental means, has proved to be of enormous usefulness. It was in the ninth revision of the United States Pharmacopoeia, in 1936, that a chapter of 10 pages was included dealing with "Hydrogen Ions and pH." In an introductory note it was stated that the concentration and activity of hydrogen ions "in many instances affect the stability, therapeutic activity, and pharmaceutical elegance of medicaments in aqueous or hydroalcoholic solutions."

There is today hardly any pharmaceutical preparation forming hydrogen or hydroxyl ions that is not tested as to its pH or adapted to the pH degree thought to be most desirable for the purpose concerned. "The literature of the past 25 years contains the reports of several hundred investigations in which pH measurements played an important part from the pharmaceutical standpoint."¹⁹

Modes of Administration

It is understood that the change in the ways and means of testing drugs during the last one hundred and fifty years followed not only the general scientific progress but was caused to a rather great extent by the change in the kind of drugs used, which

¹⁹ Remington's Practice of Pharmacy, 9th. ed., Easton, Pa., 1948, p. 168.

resulted from the same progress. But what about the pharmaceutical modes of application in which the drugs of our time are consumed by the patient? Are they still the same as they have been for centuries, if not even milleniums, or do they too show some "application of science"? The answer is that they do and that this phase of pharmaceutical research, although not given much attention, is as important as it is significant. A few examples may serve as an illustration.

The Paracelsist concept of the isolation of the essential from the then used drugs of vegetable, animal and mineral origin by dissolving it out of the raw material and leaving behind the inert, the "caput mortuum" (meaning the dead matter) had led to an enormous number of tinctures and semi solid extracts. Up to the early nineteenth century all of the tinctures and those extracts not representing boiled down products of decoctions or infusions were prepared by maceration, i.e. by steeping the drugs concerned in an appropriate, mostly hydroalcoholic menstruum. This is still the method of choice in some cases. But in general the method of maceration has been replaced by that of percolation or displacement. Although first used and recommended for pharmaceutical purposes in France, this process of extraction has been decidedly developed in its principles as well as in its technique, by American pharmacists since its admittance into the United States Pharmacopoeia in 1842 (second revision). While "in extraction by maceration, the forces which are active . . . are mainly osmosis and diffusion, in percolation the force of gravity, hydrostatic and atmospheric pressures, surface tension and capillary attraction, also play a part."²⁰ and their recognition has served as the basis of the steady perfection of the process.

One of the remarkable features of the most representative products of percolation, the fluidextracts, has been their uniformity in strength, each cubic centimeter of liquid representing the soluble components of one gram of the dried drug concerned. It is of great historical interest that it was this class of preparations which served as the testing grounds for an idea which, with much justification, has been called "the most important advance in phar-

²⁰ A. G. DuMez, *Extracts*, in *American Pharmacy*, vol. on *Fundamental Principles and Practices* . . . , 2nd ed., Philadelphia 1948, p. 172.

macy that has occurred in modern times, *viz*, the application of the principle of standardization . . . of preparations of drugs." In 1879, "with no flourish of trumpets and little realization of what it heralded," Parke, Davis & Company, Detroit, Mich. brought on the market "a preparation known as *Liquor Ergotae Purificatus*, which was a fluid preparation of ergot, standardized by a simple form of assay so that each different lot was of uniform character. . . . With this there began a systematic investigation of the possibility of rendering uniform fluid preparations of many drugs with the result that in February, 1883, there was publicly announced a list of twenty normal liquids which were actually fluid extracts standardized by some form of assay, in most cases an estimation of the alkaloids which they contained. The man responsible for the beginning of these assayed fluid extracts and who established the analytical methods for their control is Dr. A. B. Lyons"²¹, a pharmacist with an M.D. degree who went through in his career all possible phases of pharmaceutical activity, that of a practicing pharmacist, as well as that of a teacher, editor, author, chemist in government service and in manufacturing industry.

Paracelsus thought of the human body as of a chemical laboratory. To François de le Boe Sylvius (1614-1672), the real founder of the iatrochemical theory, it was what we would call today a *biochemical* laboratory. His theory was a kind of compromise between humoral pathology and the ideas of Paracelsus; its vantage point is what he called "fermentation" and to which he attributed much too far reaching physiological effects. He had recognized the enzymatic power of what he called ferments. But as it is well known, it took the work of Louis Pasteur (1822-1895) to find that "fermentation" is nothing but "the digestion of carbohydrates by bacteria" or, to put it in another way, "the result of bacterial digestion accomplished by the action of enzymes."²²

Fermentation serves, looked at from a utilitarian point of view, a constructive as well as a destructive end. As far as pharmacy is concerned, the constructive value has until quite recently been restricted to the use of fermentation for the clarification of medicinal

²¹ Fr. O. Taylor, Forty-Five Years of Manufacturing Pharmacy, *J. Am. Pharm. Assoc.*, 4: 473, 1915.

²² I. B. Sprowls, Jr., Bacteriologic Technic, in *American Pharmacy*, vol. on Fundamental Principles and Practices . . . 2nd. ed., Philadelphia 1948, p. 198.

fruit juices and wines. It has gained in importance as an indispensable process in the production of antibiotics and much research has been devoted to the problem of rendering this process as efficient as possible with respect to yield and convenience.

Of more general concern in pharmacy has been the avoidance of the destructive power of enzymes, *i.e.* the problem of killing the bacteria concerned and preventing them from entering into the products to be protected. The sterilization by physical means, initiated by Pasteur (although for an individual case, vinegar, already recommended by the apothecary Scheele in 1782, and by chemicals, advocated by the physician Joseph Lister (1827-1912), has been subject to incessant studies with regard to its application in pharmacy and has been adapted to the individual peculiarities of the substances in question. The most recent development in this field is the use of a high-voltage electron beam for instantaneous sterilization of package material. Furthermore, experiments are in progress on the basis of sterilizing effects of radio-isotopes from the atomic piles. These investigations are still going on in the laboratories of the manufacturing industry as well as in the Schools of Pharmacy.

The antiseptic and aseptic bandages, cottons, etc., filling the shelves of our pharmacies, testify to the good use to which the respective theories have been put. Their practical importance is paralleled by an invention made by a French apothecary, Stanislas Limousin (1831-1887) in 1886: the ampul. It offers an excellent example for the translation of scientific findings into pharmaceutical technic for the benefit of as perfect a mode of administration as possible. The necessity of sterility for hypodermic medication proven, the problem was how to achieve it, how to avoid later contamination and how to make the application as simple as possible. All these requirements were solved by Limousin by (1) employing "the method of Mr. Pasteur" in sterilizing the contents of his new containers, the ampuls; (2) limiting the size of these containers to a volume of one dose of application only; (3) by providing his containers with an elongated, narrow neck which could be drawn out, sealed by heat and easily broken off when its contents were to be applied. The report given by Limousin on his

invention is of the utmost clarity and reveals an astounding insight as to the requirements to be met.²³

It was, by the way, the same ingenious pharmacist to whom the world is indebted for the construction of the first apparatus for the internal administration of oxygen. The treatment of disease by inhalation goes back to the late eighteenth century. But just the development of a convenient method of obtaining pure oxygen and simultaneously administering it offered great difficulties. It was on the instigation of the well known French physician J. N. Demarquay, that Limousin went to work. In 1866-67 he had solved the problem. In 1874 Limousin opened a special room for oxygen inhalation in connection with his pharmacy. "Who, in a dangerous phase of disease", exclaims A. Goris, "has not become acquainted with the oxygen apparatus?" and he goes on to say that "the development of this therapy is undoubtedly due to the initiative of Limousin."²⁴

Percolates, aseptic, antiseptic, standardized and sterilized products are of rather recent vintage. But the older pharmaceutical modes of application have by no means escaped a thorough checking with regard to the application of new scientific findings and concepts. The development of the preparation of ointments from the middle of the nineteenth century up to our time may well serve as an example. Up to that time it was oils and almost every kind of animal fat, with the occasional addition of wax or suet, that made up the ointment bases, the ointments themselves representing semi-solid smears used on the basis of empirical experiences only. It was already a great progress when, in the nineteenth century, the ointment bases were classified into three types according to their power of penetration into the skin, *i.e.* into epidermic ones, acting chiefly on the diseased epithelium; the endodermic ones, to be effective on the deeper layers of the skin; and the diadermic ones, intended to penetrate the skin and to transport the medicinal contents of the respective ointments into the organism. Recent evidence has however, shown that "it is not the penetration of the base in a direct sense which determines

²³ St. Limousin, Ampoules hypodermiques; nouveau mode de préparation des solutions pour injections hypodermiques, *Arch. Pharm.* 1: 145, 1886; A. Goris, Hommage à Stanislas Limousin, Suppl. à la Pharm. Française de Mars et Avril 1939.

²⁴ A. Goris, *l.c.*, pp. 1 and 2.

whether absorption will occur through the intact skin or not, but the chemical and physical (solubility) relations between the drug and the base which determine whether absorption will occur and in what amounts it will occur."²⁵ It is understood that these new scientific concepts have initiated a new field of research profoundly changing not only the concept but also the substance of what we call an ointment. Animal fats of old have been replaced almost completely by petrolatum and (or) woolfat and, to an increasing extent, by synthetic ointments bases. This is allowing a more and more definite choice of the most adequate basis for the medicinal substances to be incorporated and for the desired therapeutic effect.

There were no changes in the concept of another mode of administration of old, the pills. They were created in time immemorial as probably the first medicinal product allowing a rather definite dose corresponding with the therapeutic action to be achieved and offering the advantage of small size which made their administration convenient. It is these very same characteristics, exact dosage and convenience, which up to the present time have all the more saved them from falling into oblivion as in some cases their later competitors, the tablets and the capsules, are not fitted.

Rather early attempts were made to overcome the offending taste or smell of some substances worked into pills by coating the latter. It was the Arab Avicenna (980-1035) who recommended the gilding of such pills, while his compatriot Rhazes (865-925) advocated the less elegant but at least as efficient enveloping of repulsive pills with mucilage which was obtained from psyllium seed. However, not until the nineteenth century did the coating of pills become a generally used method serving not only the concealment of bad taste or smell but also the protection of the pills from becoming hard and insoluble. The first such process was the coating with gelatine made known by the French pharmacist, Garot, in 1834. Later on coating with sugar or chocolate became quite common.

While these coatings are serving an aesthetic or preservative rather than a distinct medical purpose, this is different as far as

²⁵ L. Busse, *Ointments, Cerates, Plasters, Cataplasms*, in *American Pharmacy*, vol. on *Fundamental Principles and Practices* . . . 2nd ed., Philadelphia 1948, p. 317.

the so-called enteric coating is concerned. It was the medical desire to have certain drugs act in the intestinal tract rather than in the stomach which caused the search for coatings allowing pills to pass the latter undissolved while being disintegrated in the intestines.

In 1885 the well known German physician, P. G. Unna, recommended for this purpose coating with keratin, while the usefulness of salol was stated in the Viennese *Pharmaceutische Post* in 1892. Casein, stearic acid, shellac and combinations of all the substances listed were tried out. The theory behind it was, that these coatings, being acid insoluble, would not dissolve in the stomach. But being alkali soluble, they would dissolve in the intestines. More recent information on the wide differences in stomach acidity in various individuals at different times and the disclosure of the fact that the duodenum frequently has an acid reaction, has rendered the above theoretical considerations invalid, hence the pharmaceutical attempt at their realization unsufficiently grounded. Now research is going on on the basis of the time required for the disintegration of the coating rather than on the acidity or alkalinity of portions of the alimentary tract.²⁶ It is of interest that the time and place of disintegration can be and are now determined more specifically by the use of Xrays.

Drugs with Delayed Action

Another interesting example for the meeting of medical requirements by scientifically based pharmaceutical technique has been offered during the last two decades. It had been observed that in a number of cases modern drugs, especially if used in form of parenteral injections, showed a rapid and quickly disappearing effect instead of the desired slow and prolonged activity. Pharmaceutical technique and consideration has solved this problem to a remarkable extent by

1. the creation of resorption depots. To achieve that, the effective drugs have been dissolved in or mixed with resorption delaying substances. Another procedure has been the application of but slightly soluble, hence slowly resorbed modifications of the drugs concerned.

2. the creation of transformation depots. In this case drugs are applied which as such are ineffective but in the body are transformed,

²⁶ L. M. Ohmart, *Masses, Pills, Troches and Tablets*, in *American Pharmacy*, vol. on *Fundamental Principles and Practices* . . . 2nd ed., Philadelphia 1948, p. 442.

in a rather slow process, into the effective substance.

3. the creation of blockade depots. Here it is by blocking the natural ways of excretion preventing a quick removal of the effective drugs from the body that the desired prolonged action is achieved.

Experience has shown that often a combination of these methods serves the purpose best.

The Avoidance of Incompatibilities Systematized

One of the most important problems of pharmacy through the ages has been the avoidance of incompatibilities. Drug mixtures that were desirable from a therapeutical point of view proved to miss the point or even to be harmful because of chemical reactions between the individual ingredients. The situation was not too difficult as far as inorganic chemicals were concerned. Incompatibilities of organic compounds were usually memorized as series of specific examples, taking each case as an isolated problem.

It has been quite recently that the problem of incompatibilities of organic compounds has been attacked systematically in terms of chemical reactivity and solubility. No longer is it necessary to obtain complete data for all drugs on all chemical and physical properties and solubility under all conceivable circumstances. It has been found that each chemical class offers particular incompatibility problems. Hence knowledge of the structural formula and the application of modern electronic theories is often sufficient for the prediction of all the mutual reactions of the compounds concerned, *i.e.* all the incompatibilities to be expected.

There has been attempted a methodical listing of the various classes of organic compounds with special regard to their solubilities and chemical properties representing a kind of periodic table of compatibilities and incompatibilities. It is hardly necessary to stress the importance of this new way of approach to the filling of prescriptions where decisions have to be made at the spur of the moment. It means a new safeguard for the physician, the pharmacist and, above all, the patient.²⁷

A beginning has been made furthermore to use this avenue of attacking the problem not only qualitatively but also quanti-

²⁷ D. E. Wurster, *Incompatibilities of Organic Compounds in American Pharmacy* vol. on Pharmaceutical Compounding and Dispensing, Philadelphia 1949; Personal communication by T. Higuchi.

tatively. In many cases it is possible to predict, for instance, the exact pH or concentration of solubilizing agents necessary to hold certain drugs in solution in presence of other constituents.

Particle Size as a Pharmaceutical Problem

The importance of the grade of fineness or, to give it the modern term, particle size, of powders to be employed either as such or as material for pharmaceutical preparations was recognized long ago. It has been for this reason that to the old instrument and symbol of pharmacy, the mortar and pestle, another one, the sieve, was added. But it was regarded in this country as a remarkable progress when, on the instigation of a Philadelphian pharmacist, J. B. Moore, the United States Pharmacopoeia, in 1863, classified the powders listed into five groups according to their degree of fineness, making the width of sieve meshes through which they had to pass, the criterion.²⁸

This method of classification is, with some variations, still—and for good reasons—applied today.²⁹ Its range is naturally rather limited. There were examples of differences known in the therapeutical effect of chemicals by their differences in particle size long before the advent of colloidal chemistry and the recognition of the connection between surface area and adsorption. In discussing the various modes of preparation of mercurous chloride (calomel), using the process of sublimation and the most recent one of “causing the calomel in vapour to come in contact with steam in the subliming vessel,” G. B. Wood and Franklin Bache in their United States Dispensatory issued in 1836 state that “calomel made by this [the latter] process . . . is lighter than that ordinarily prepared by the proportion of three to five . . . and as it is much finer than when obtained by levigation and elutriation, it probably possesses more activity as a medicine.”³⁰ In the following edition the word “probably” had disappeared. Attempts on a scientific basis to determine specific surface areas and surface average diameters of pharmaceutical powders and finally to produce powders of desired particle size have only quite recently been made.

²⁸ Kremers-Urdang *History of Pharmacy*, 2nd. edition, Philadelphia 1951, p. 344.

²⁹ United States Pharmacopoeia XIV, 1950, pp. 712-14.

³⁰ The United States Dispensatory, 3rd ed., Philadelphia 1836, p. 868.

As could be shown through experiments on colloidal sulfur, spray-drying appeared to serve the latter purpose quite effectively. These investigations have successfully opened up a very promising field and I am pleased to be able to state that pioneer work in this direction has been done in the School of Pharmacy of the University of Wisconsin.³¹

Splits and their Care

We are living in a time of splits. We have split the atom and the world has been split wide open in a terrific clash of conflicting ideologies defying all routine attempts of synthesis because of the lack of a common conviction that could be appealed to. There has been, fortunately, one field of human endeavor that has proven itself as a common ground of all mankind however deep the splits have been in the political and ideological area: the search for the protection and restoration of health.

It is of more than practical significance that throughout the second world war one and only one department of the League of Nations survived and, although curtailed as to its means and members, continued its work: the department devoted to planning and acting in the interest of world health. Even before the United Nations replaced the deceased League of Nations, this department was reestablished as the World Health Organization. It is closely connected with, but not an official part of, the United Nations. Within the frame of the old League of Nations and now of the World Health Organization, a permanent committee of pharmacopoeial experts has since 1938 devoted itself to the task of furnishing the people all over the world with the most recent pertinent "applications of science to pharmacy" for admittance into their national pharmaceutical standards. A collection of the suggestions concerned is to appear in the near future under the title "Pharmacopeia Internationalis".³² Supplements to be issued whenever thought necessary are supposed to keep the information up to date. The more or less complete acceptance of these suggestions will be based—and that too is symptomatic—not on coercion but on the

³¹ J. V. Swintosky, S. Riegelman, T. Higuchi and L. W. Busse, Studies on Pharmaceutical Powders and the State of Subdivision, *J. Am. Pharm. Assoc. Sc. Ed.* 38: 210-215, 308-313, 378-381, 1949; 39: 444-450, 1950.

³² G. Urdang, *The Development of Pharmacopoeias*, New York 1950, pp. 23-25.

actual and ideal merits of the work and the national needs and particularities of the individual nations concerned.

Here then is convincing proof of international cooperation which offers some hope in an almost hopelessly confused world. As exemplified in this conference, it is the constructive instead of the destructive "application of science". By helping to cure the bodies of all people in all countries we might proceed to curing their minds and souls and finally even the treacherous splits so tragically denying the brotherhood of man.

New Appointments to the A.Ph.A. staff in Washington, made necessary by the increased activity of the Association and the national emergency, are as follows:

Mr. Bernard Zerbe who becomes Executive Editor of the Practical Pharmacy Edition of the Journal. In this capacity he will have charge of the production of the Journal, management of the editorial office and contacts with the advertizers. Mr. Zerbe received his training in journalism at the Universities of Pittsburgh and Southern California. For two years he was assistant to the secretary of the National Association of Chain Drug Stores. He has had a wealth of experience in retail pharmacy as well as wide contacts with all phases of the drug industry and for the last nine years has been managing editor of the **American Druggist**.

Dr. Samuel Goldstein replaces Dr. Albert M. Mattocks as acting director of the A.Ph.A. Laboratory. Dr. Goldstein was for many years with the Maryland Board of Health and is well known for his work on prescription tolerance. While problems of drug standardization and the development of N.F. monographs will continue to be the principal activity of the Laboratory, it is expected Dr. Goldstein will devote considerable attention to perfecting a system of tolerances and techniques for extemporaneous prescription compounding and will enlarge the activities of the Laboratory along lines of special interest to practicing pharmacists.

Mr. Donald B. Crowell will work toward the further improvement of the library, museum, and general information services to members of the Association, to government agencies and related professional organizations. Also he will work with the General Secretary in making necessary contact with agencies of the government for the reciprocal exchange of essential scientific and professional information and will assist the Committee on Public Relations in the promotion of National Pharmacy Week and the continuing health education program. Mr. Crowell was formerly engaged in public relations activities in the office of the Surgeon-General of the Army and the Air Force and the publication division of the Mayo Clinic at Rochester, Minnesota.

A History of the American Foundation for Pharmaceutical Education*

ERNEST LITTLE, PH.D.

Member of the Board of Grants
American Foundation for Pharmaceutical Education

The history of any organization should begin with something tangible, something real, such as the first meeting, or a series of events leading up to such a meeting.

If one goes much beyond that and attempts to determine with whom the idea originated, who first conceived the project, conflicting claims are bound to result, and no constructive purpose is served.

In writing this brief history of the American Foundation for Pharmaceutical Education, it is recognized as an offspring of the National Drug Trade Conference, and certain Conference activities and decisions which led to its formation are presented.

For a number of years prior to the formation of the Foundation, the writer was assigned the responsibility of acting as Chairman of the Committee on Endowment of the National Drug Trade Conference. Over a period of time the reports of this Committee dealt with the financial needs of our colleges of pharmacy, and with ways and means of meeting them. In all probability these reports, as well as the reports of previous Committees, helped pave the way for the Foundation which was to follow. Mr. Philip I. Heusler, Dean Wortley F. Rudd, and others served as chairmen of this important Committee and helped to create in the Conference a greater awareness on the part of its constituent members of their responsibility toward pharmaceutical education.

*Authorized for publication by the following
Foundation Committee: James F. Hoge, Ernest Little, Robert L. Swain, Chairman.

Another helpful contributing factor was the organization of an "All Industry Scholarship Committee". This Committee was sponsored by the National Wholesale Druggists' Association and activated by its Executive Vice President, Dr. Edwin L. Newcomb.

The Scholarship Committee was the outgrowth of a meeting of representatives of pharmaceutical industry held at the Republican Club in New York City, on November 26, 1939. This Committee had a very adequate comprehension of its opportunities and responsibilities, and aroused in the drug industry a still greater feeling of responsibility toward pharmaceutical education and our colleges of pharmacy.

Later, when the American Foundation for Pharmaceutical Education was created, it was agreed by the members of this Committee and by the Directors of the Foundation that the scholarship activities of the All Industry Committee should be turned over to the American Foundation for Pharmaceutical Education which was sponsored not only by pharmaceutical industry, but by all national pharmaceutical associations.

It was to the credit of pharmaceutical manufacturers that one of their representatives concluded it was time for the Committee on Endowment to operate a little more effectively. At the December, 1939 meeting of the National Drug Trade Conference, Dr. Carson P. Frailey, President of the Conference, expressed the opinion that the time had come when the Committee should present a report which might result in some definite action on the part of the Conference.

President Frailey expressed the conviction that the drug industry appreciated the wholesome development which had taken place in the field of pharmaceutical education and desired to help maintain such progress. He pointed out that a larger number of pharmacy college graduates were entering the manufacturing field each year, and that manufacturers felt an increasing obligation toward the training of these men. President Frailey expressed the hope that at the next annual meeting the Committee might offer concrete recommendations as to how such contributions might be encouraged and facilitated.

A few weeks thereafter, the Committee on Endowment sent a questionnaire to the Dean of every college of pharmacy in the United States inquiring as to their financial needs. The data contained in the returned questionnaires revealed serious needs and deficiencies in our colleges, and furnished the basis of the Committee's December, 1940 report to the Conference.

At this meeting the Committee pointed out that the question of financial aid to colleges of pharmacy had been before the Conference for many years without any definite program developing. The Committee recommended that the Conference sponsor the formation of a Foundation made up of representatives of each of the associations holding membership in the National Drug Trade Conference, which should have the responsibility of collecting and allocating funds in behalf of pharmaceutical education. It was suggested that such an organization might, in general, be patterned after the Carnegie or Rockefeller Foundation.

The Committee pointed out that if the drug industry would agree to make annual contributions to such a Foundation that, eventually, a very significant sum might be established and that such an achievement would be of great benefit to pharmaceutical education and to the profession in general.

The Committee further pointed out that the organization of such a Foundation would in no way prevent a donor from making a contribution to any college directly, if he chose to do so. It would, however, provide a more effective method of rendering assistance to colleges than had prevailed in the past.

The Conference unanimously endorsed, in principle, the recommendations of the Committee on Endowment and requested that the Committee continue its work and present as complete a report as possible at the 1941 meeting.

With this encouragement the Committee, made of Mr. S. B. Penick representing the American Drug Manufacturers' Association, Dr. George D. Beal of the American Pharmaceutical Association, Mr. Harry Noonan of the American Pharmaceutical Manufacturers' Association, Mr. David L. Maxwell of the Federal

Wholesale Druggists' Association, Dr. Robert L. Swain of the National Association of Boards of Pharmacy, Mr. Rowland Jones of the National Association of Retail Druggists, Dr. E. L. Newcomb of the National Wholesale Druggists' Association, Mr. James F. Hoge of the Proprietary Association, and Dr. Ernest Little of the American Association of Colleges of Pharmacy, Chairman, applied themselves to their task. Many meetings were held, and in December, 1941, a thirty-page mimeographed presentation gave the Conference what the Committee hoped might be its final report.

This report contained a proposed Statement of Purpose and Program, the Certificate of Incorporation and proposed By-Laws of the Foundation. After a lengthy discussion of all phases of the report and its recommendations, the Conference unanimously approved the following resolution:

"RESOLVED that the National Drug Trade Conference expresses its approval of the formation of the American Foundation of Pharmaceutical Education as an independent agency, and be it further resolved that the Conference urge its constituent members to participate in the formation of the American Foundation for Pharmaceutical Education, and to do everything which they deem proper and appropriate to insure its success."

The name, American Foundation for Pharmaceutical Education, suggested by Dr. Robert L. Swain, was considered by the Committee to be superior to other names submitted for consideration and highly satisfactory for the purpose intended.

Copies of revised and amended Statements of Purpose and Program, the Certificate of Incorporation and the By-Laws are now available in the office of the Foundation, 1450 Broadway, New York 18, N. Y., and will be furnished as requested. It is hoped that many of our readers will be interested enough to request copies of these pamphlets and, after careful reading, preserve them for reference in their files.

Among the more important objectives set forth in the Statement of Purpose and Program, as found in the Prospectus, are:

1. To provide an adequate, well trained and reliable personnel to man the retail pharmacies of the country.

- II. To furnish pharmaceutical industry and allied manufacturing concerns, hospitals, governmental agencies, college faculties and other professional fields with technically and scientifically trained personnel.

In furthering these objectives the Prospectus states that the Foundation will, among other activities:

- I. Help worthy colleges develop strong undergraduate programs;
- II. Support graduate work in colleges qualified to carry on such programs in a creditable manner;
- III. Encourage scientific research, both as a necessary component of graduate work, and as special projects.

The Prospectus states equally specifically that the Foundation will not:

- I. Make grants for other than specific purposes;
- II. Make contributions to capital deficiencies;
- III. Render financial assistance to colleges which do not show fair promise of being able to become established on a sound financial and educational basis, and make a worthy contribution to the field of pharmaceutical education.

The By-Laws provide that the policies and operation of the Foundation shall be controlled by an unsalaried Board of Directors, although certain responsibilities are specifically delegated to the Members of the Foundation.

The membership of the Foundation is made up of its member associations, and all members of the Board of Directors.

The original By-Laws provided that the Board of Directors should consist of one representative from each of the nine national pharmaceutical associations holding membership in the Foundation, with the exception that the American Association of Colleges of Pharmacy should have three representatives, one of whom would be the Chairman of its Executive Committee, who would serve during his term of office in that capacity. It was provided that the other ten Members of the Board of Directors should serve for a term of five years and might be re-elected by the Members if their constituent organizations so recommend.

The Board of Directors constitutes the managing body of the Foundation and is responsible for the Foundation's funds, both principal and income. It is provided, however, that all allocations

shall be supervised by a Board of Grants of five members who are obviously well qualified for such a responsibility.

There are further restrictions pertaining to Foundation grants, involving both the Board of Grants and Board of Directors, which are set forth in considerable detail in the Foundation's By-Laws.

The By-Laws also provide that there shall be an Executive Committee of seven members which shall include one of the representatives of the American Association of Colleges of Pharmacy. It is the responsibility of this group to transact the Foundation's business between meetings of the Board of Directors. All members of the Board, however, shall have the opportunity of voting on recommendations to and allocations by the Board of Grants.

The By-Laws provide for one regular annual meeting on the first Monday in April, and such special meetings as may be deemed advisable.

It is also provided that the President and Members of the Board of Directors shall publish an annual report, setting forth important items in the operation of the Foundation. Copies of such report are made available upon request to the Secretary.

These are but a few of the many provisions set forth in the By-Laws which will be gladly furnished upon request.

The Incorporators of the Foundation met on October 1, 1942 at 41 East 42nd Street, New York City. The following were in attendance:

Mr. Charles S. Beardsley, representing The Proprietary Association
Mr. Joseph J. Dreyer, of the Federal Wholesale Druggists'
Association

Dean H. Evert Kendig, of the American Association of Colleges of
Pharmacy

Dean Ernest Little, of the American Association of Colleges of
Pharmacy

Dr. Edwin L. Newcomb, of the National Wholesale Druggists'
Association

Mr. Harry Noonan, of the American Pharmaceutical Manufacturers
Association

Dean Charles H. Rogers, of the American Association of Colleges
of Pharmacy

Dr. Robert L. Swain, of the National Association of Boards of
Pharmacy

Dr. Hugo H. Schaefer, of the American Pharmaceutical Association
Mr. James F. Hoge, Attorney

Mr. Charles H. Evans was unable to attend and was represented by Dean Schaefer. Mr. Hugh P. Beirne of the National Association of Retail Druggists was also unable to attend, as was Mr. S. B. Penick of the American Drug Manufacturers' Association.

Dean Ernest Little was chosen Chairman and Mr. James F. Hoge Secretary of the meeting.

The Secretary read a certified copy of the Certificate of Incorporation which was received and ordered incorporated in the Minutes of the meeting.

The Secretary also read the By-Laws of the corporation which were adopted in amended form and ordered incorporated in the Minutes of the meeting.

The Members of the Board of Directors, as named in the Certificate of Incorporation, were confirmed as Directors to serve until the first annual meeting. These first Directors of the Foundation were Messrs. Charles S. Beardsley, Hugh P. Beirne, Joseph J. Dreyer, Charles H. Evans, H. Evert Kendig, Ernest Little, Edwin L. Newcomb, Harry Noonan, S. B. Penick, Sr., Charles H. Rogers, and Robert L. Swain.

Upon motion duly made, seconded and carried, the following associations were elected as Members of the corporation:

- American Association of Colleges of Pharmacy
- American Drug Manufacturers' Association
- American Pharmaceutical Association
- American Pharmaceutical Manufacturers' Association
- Federal Wholesale Druggists' Association
- National Association of Boards of Pharmacy
- National Association of Retail Druggists
- National Wholesale Druggists Association
- The Proprietary Association

Following the transaction of other business this meeting of the Incorporators was adjourned.

The first meeting of the Board of Directors was held at 41 East 42nd Street, New York City, on October 1, 1942, at 2:45 P.M. The following Directors were in attendance. Messrs. Beardsley, Dreyer, Kendig, Little, Newcomb, Noonan, Rogers and Swain. Mr. James F. Hoge, Attorney, was also present.

The By-Laws approved by the Incorporators at their meeting were approved and adopted by the Directors.

The first Officers elected at this meeting were:

President.....	Ernest Little
Vice President.....	Charles S. Beardsley
Secretary.....	Edwin L. Newcomb
Treasurer.....	S. B. Penick, Sr.

Mr. James F. Hoge was elected Counsel of the Corporation.

The membership of the first Executive Committee was constituted as follows: Messrs. Beirne, Noonan and Swain as elected Members, to serve with the Officers, Messrs. Beardsley, Newcomb, Penick and Little, Chairman.

At this meeting Mr. James F. Hoge was elected as the first honorary member of the Corporation.

The official seal of the Corporation was adopted and other important business transacted.

The first meeting of the Executive Committee was held at the Hotel Pennsylvania, New York City, on December 9, 1942. The following were in attendance: President Little, Vice President Beardsley, Secretary Newcomb, Executive Committeemen Noonan, Swain and Beirne, Director Kendig and Counsel Hoge.

Various matters pertaining to the operation of the Foundation were discussed at this meeting and the work of the Foundation formally started.

A tentative report of the Nominating Committee for the annual meeting was received. A Committee on Prospectus was appointed. Counsel Hoge reported on deductions for tax exemption of donations to the Foundation. Dean Kendig reported the preliminary considerations of a special committee appointed to consider membership on the Board of Grants.

The first Annual Meeting of the Foundation was held at 330 West 42nd Street, New York City, on Monday, April 5, 1943, at 2:30 P.M. All Association Members were present.

The Treasurer's Report revealed that the first two contributions to the Foundation were made by Messrs. Beardsley and Penick. The cost of incorporation was reported as \$215.53. A balance of \$1,284.37 remained in the Treasury.

At this meeting it was decided to admit the National Association of Chain Drug Stores to membership, thereby increasing the number of Association Members to ten. Counsel Hoge was re-

quested to draft such changes in the By-Laws as might be necessary to provide for its representation on the Board of Directors.

At this first Annual Meeting Dr. Carson P. Frailey was elected as the second Honorary Member of the Foundation.

Immediately following this meeting, the second Meeting of the Board of Directors was called to order. The most important item of business was the election of Mr. George V. Doerr as the second President of the Foundation. Mr. Doerr held this office for six years and contributed richly to the welfare of the Foundation.

The other three Officers, Mr. C. S. Beardsley, Vice President; Mr. S. B. Penick, Sr., Treasurer; Dr. E. L. Newcomb, Secretary, were re-elected for a term of one year.

It should be pointed out that Mr. Beardsley held the office of Vice President until his election as President in 1949. Dr. Newcomb served as Secretary and Managing Director until the time of his death on September 1, 1950. Mr. Penick served as Treasurer for eight years and Mr. Hoge continues as our Counsel.

Mr. Hugh P. Beirne, Dr. Ernest Little and Dr. Robert L. Swain were elected to serve with the Officers of the Foundation as Members of the Executive Committee.

Another important item of business at this meeting was the election of the first Board of Grants, as follows:

Dr. Guy Stanton Ford
Dr. William Mather Lewis
Mr. Charles J. Lynn
Dr. Gilbert Wilcox Mead
Mr. Edward S. Rogers

Dr. Ford was later elected Chairman of the Board of Grants, a position which he still holds. Mr. Lynn has also continued his membership on this Board. Messrs. Rogers, Lewis and Mead are deceased.

From this time on, many meetings of the Board of Directors and the Executive Committee were held between Annual Meetings. Only the more important items of business transacted will be commented upon in this brief history.

The first joint meeting of the Directors and Members of the Board of Grants was held on September 13, 1943. All members

of the Board of Grants, eight Members of the Board of Directors and the Secretary were in attendance.

At this meeting the Directors approved the issuing of letters for the solicitation of funds and the Secretary was directed to request the American Drug Manufacturers' Association, the American Pharmaceutical Manufacturers Association and The Proprietary Association to send letters to all of their members urging liberal support of the Foundation.

The Secretary was also directed to advise the Board of Grants that the Directors looked with favor on the resolution passed by the American Association of Colleges of Pharmacy requesting the granting of funds to the extent of \$200 for each of two scholarships in each of the colleges holding membership in the American Association of Colleges of Pharmacy, and that funds had been made available for such grants.

Two items of unusual importance are found in the Minutes of a meeting of the Board of Directors held on January 17, 1944.

A resolution authorizing the creation of a Finance Committee was unanimously adopted. The President later appointed Director Beardsley, Counsel Hoge and Director Penick, Chairman, as members of this Committee.

The following important item is also found in the Minutes of this meeting:

"Mr. Lynn pointed out that it was evident that if the work of the Foundation was to be continued it would need far more than one million dollars as originally planned. He expressed the view that the Foundation should consider laying plans for securing at least five million dollars. Treasurer Penick felt this was a sound recommendation for future consideration. President Doerr suggested that a five year program for five million dollars be prepared for consideration at the annual April meeting of the Directors."

A joint meeting of the Executive Committee of the American Association of Colleges of Pharmacy and the Executive Committee of the Foundation was held on April 3, 1944. Twenty-two were in attendance, thus providing a good representation of the two groups, plus some additional Foundation Directors.

Many matters were discussed and decisions arrived at. In the Minutes of the meeting we find the following important statement:

"It was the consensus of opinion of all in attendance that the Foundation should, during the war emergency, give assistance to worthy colleges of pharmacy, where necessary to keep them in operation."

At the second Annual Meeting held on April 4, 1944, Counsel Hoge presented a resolution to amend the By-Laws to provide for representation of the National Association of Chain Drug Stores on the Board of Directors of the Foundation. Upon motion duly made and seconded, this change in the By-Laws was unanimously accepted and Mr. Fred J. Griffiths was elected to the Board of Directors as a representative of the National Association of Chain Drug Stores for a term of five years.

Treasurer Penick reported that total collections to date were \$421,925.00 with expenditures of \$34,926.92.

At a meeting of the Board of Directors following this Annual Meeting, Dr. F. J. Cullen was unanimously elected the third Honorary Member of the Foundation.

We find in the Minutes of this meeting a motion "to advise the Board of Grants that the sum of \$100,000 was made available, from which the Board might use such part as was deemed desirable and necessary to aid colleges of pharmacy at the present time".

The first request for funds for graduate Fellowships stems from a meeting of the Board of Grants held on May 17, 1944. In a communication to the Board of Directors from the Board of Grants, we find the following statement and request:

"The Board considered the question of the desirability of awarding, at this time, a limited number of graduate Fellowships because of the urgent need of turning out qualified teachers in the field of pharmacy at an early date. It was the unanimous opinion that a number of such Fellowships should be awarded in the very near future. The Board therefore requests that the Directors of the Foundation make available to the Board of Grants a fund of at least \$15,000 which the Board of Grants may use for awarding graduate Fellowships."

This request, which was granted by the Board of Directors, is of special significance in view of the fact that the support of graduate Fellowships has developed into the major responsibility of the Foundation, necessitating an annual expenditure of approximately \$150,000 a year for this one project.

Also at this meeting, the Board of Grants allocated \$62,000 as emergency war aid to thirteen colleges of pharmacy requesting such support.

It was evident at this early date, only two years following its organization, that the Foundation had developed into a useful and much needed agency.

At a meeting of the Executive Committee held on July 26, 1944, we find the question of the establishment of an invested fund again considered without definite action being taken. The statement in the Minutes of this meeting covering this item is as follows:

"The Executive Committee next gave brief consideration to an outline of a plan for the Foundation to conduct a campaign to raise a fund of not less than five million dollars for permanent investment, the income from which may be used for the support and development of pharmaceutical education in America. Time did not permit the Committee to give adequate consideration to the plan. It was, therefore, held for discussion at the next meeting of the Executive Committee."

We find that this very worthwhile suggestion has thus been handed down from meeting to meeting without any definite action being taken thereon.

It is hoped by many that such a fund may be established, thereby making the American Foundation for Pharmaceutical Education a "*Foundation in fact*" as well as in name.

At this July 26th meeting the Executive Committee met with representatives of the American Council on Pharmaceutical Education.

Dean A. G. DuMez, Secretary-Treasurer of the Council, presented a statement concerning the work of the Accrediting Agency and stated that the Council would be deeply appreciative of any financial assistance the Foundation might give for the work of the Council.

The Executive Committee requested Secretary DeMuz of the Council to submit a three year outline of contemplated work by the Council involving an average cost of about \$3,000 a year, for consideration and study by the Foundation.

This meeting was the fore-runner of the substantial financial aid being rendered the Council by the Foundation.

One of the projects, originally presented to the Foundation by the American Association of Colleges of Pharmacy, was the need of a national survey of all branches of the profession of pharmacy. This possibility had been considered by the Board of Directors on various occasions and discussed with representatives of the American Council on Education.

Finally, as a culmination of these discussions, we find in the Minutes of a meeting of the Board of Directors held on January 23, 1946, the following action:

"A motion was made by Dunning, seconded by Swain and Bellis, that the Board of Directors of the Foundation give full approval of the proposed survey of pharmacy and pharmaceutical education by the American Council on Education, and provide funds in the amount of \$95,650 to cover the cost, with the understanding that \$35,000 would be paid to the American Council of Education for each of the first two years, and the balance of \$25,650 to cover the third year."

The motion was unanimously carried.

Subsequent developments made it necessary for the Foundation to make appropriations considerably in excess of the total of \$95,650 originally estimated. The survey, however, was creditably completed. The profession of pharmacy has profited as a result of this work and can profit still more if its practitioners have the desire and will to do so.

Among many important items discussed at a meeting of the Board of Directors held on June 25, 1946, three especially claim our attention:

I. After a lengthy discussion of the responsibility of the Foundation relative to graduate work in our colleges of pharmacy, it was unanimously agreed and approved that, **"Support of graduate Fellowships should be regarded as a major Foundation activity."**

II. **"It was unanimously agreed that 'The Foundation should restrict all grants to those colleges of pharmacy which give definite promise of making constructive contributions to pharmaceutical education.'"**

III. It was also unanimously agreed that, **"The Foundation continue its financial support of the American Council for Pharmaceutical Education in order that its work may be carried on in the most efficient manner possible. This Council, with the support of the Foundation, should be encouraged to undertake such educational studies and research as may be needed to keep our colleges of pharmacy alert, progressive and educationally sound."**

At this same meeting Director B. V. Christensen requested that funds in the amount of \$1,500 a year be appropriated for use in support of the American Journal of Pharmaceutical Education. The request was given careful consideration and referred to a special committee for study and report.

It is interesting in reading the Minutes of the Foundation to see how certain activities have slowly but definitely crystallized into the main items of Foundation support.

It becomes clear that although the Foundation has moved slowly, very slowly at times, it has nevertheless moved with a caution and a surety which is reassuring to all who are interested in its continued successful operation.

At the November 26, 1946 meeting of the Board of Directors, Treasurer Penick reported total contributions of \$1,116,943.00 and total disbursements to date of \$375,357.00. These figures stand out in bold relief when compared with the balance of \$1,284.37 reported by Mr. Penick three years earlier.

The building of an endowment fund was given further discussion at this meeting. The Minutes comment as follows:

"It was pointed out that the Foundation was not endeavoring at this time to build an endowment fund but merely to collect a sufficient amount each year to cover the costs of the program being carried on. It was emphasized, however, that a reasonable balance should be maintained as a reserve, such as that now held by the Foundation. Continuation of this policy was approved."

Director Little called attention to a resolution passed by the National Drug Trade Conference expressing the hope that the Foundation could set aside some of the contributions received each year for a permanent endowment fund. Several of the Directors pointed out that this was inadvisable at this time because of the low return on investments.

An increasing appreciation of the Fellowship program is indicated by the following item taken from the Minutes of this meeting.

"The Directors expressed the view that the awarding of Fellowships is probably the most important work that the Foundation has been engaged in, particularly in view of the great shortage of qualified instructors and professors in our sixty-eight accredited colleges of pharmacy. On motion duly made and seconded, the Board approved an

allocation of \$50,000 for use by the Board of Grants in awarding additional Fellowships during 1947."

At the January 29, 1947 meeting of the Executive Committee of the Foundation, Mr. Charles J. Lynn presented a report in behalf of the Board of Grants in which he requested an appropriation of \$15,000 to cover a limited number of Fellowships for foreign students. Mr. Lynn's request was granted and this item, in the amount of \$10,000 has been continued in subsequent budgets.

A statement is also found in these Minutes recommending "Increasing as rapidly as possible Fellowship awards for students seeking graduate degrees in pharmaceutical subjects up to at least one hundred per year, in order to provide much needed teachers for colleges of pharmacy and research workers for pharmaceutical manufacturers. This Fellowship program would call for an expenditure of about \$175,000 to \$200,000 a year."

At this meeting consideration was also given to the increasing need for the employment of a qualified person who might devote himself full time to the work of the Foundation, particularly with reference to the solicitation of funds and promoting further development of the Fellowship and Scholarship programs. The recommendation was thoroughly discussed and the President authorized to appoint a committee to give the suggestion further study.

The Teachers Summer Seminar is first found mentioned and discussed in the Minutes of a meeting of the Foundation's Executive Committee held on November 24, 1947. After a long discussion participated in by Drs. E. C. Elliott and A. G. DuMez, as well as by members of the Executive Committee, the following resolution was adopted:

"Resolved that the American Foundation for Pharmaceutical Education look with favor upon the proposal that Summer Seminars for teachers, running for four to six weeks, with an attendance of not less than twenty-five teachers, be established, and that the American Association of Colleges of Pharmacy be advised that the Foundation looks with favor upon the financing of such a seminar for the summer of 1948, and that the American Association of Colleges of Pharmacy be requested to formulate and submit detailed programs for the conduct of such proposed seminars".

The resolution was unanimously carried. Three such Seminars have been held, the last at Purdue University in June, 1951. The Foundation's budget carries an item of \$6,000 for that purpose.

At this meeting Secretary Newcomb presented a resolution adopted by the National Association of Retail Druggists in support of contributions from retail pharmacists throughout the country, in behalf of the Foundation program. This source of funds has never been utilized as it might have been. It is hoped that the Foundation may do so in the near future.

At the April 26, 1948 meeting of the Board of Directors, financial support for the American Journal for Pharmaceutical Education came into being through the following:

"Consideration was next given to a request from the American Association of Colleges of Pharmacy for funds in support of the American Journal for Pharmaceutical Education. After discussion, it was moved, seconded and carried that \$2,500 be appropriated for the use of the American Association of Colleges of Pharmacy in helping to defray the expenses of the American Journal for Pharmaceutical Education for the balance of the current year, and that a committee be appointed to confer with American Association of Colleges of Pharmacy officers as to the future financial status of its Journal." This support has been continued. The current budget carries an item of \$5,000 for this purpose.

Large scale financial support for the American Council on Pharmaceutical Education crystallized at the October 26, 1948 meeting of the Board of Directors. Director Swain presented the following resolution:

"Resolved that the American Foundation for Pharmaceutical Education provide a grant of \$20,000 to the American Council on Pharmaceutical Education for the year January, 1949 to January, 1950 for the operation and work of the Council". The motion was seconded by Director H. Evert Kendig and discussed by all Directors in attendance. At the end of the discussion President Doerr called for a vote and it was unanimously carried.

At the meeting of the Executive Committee held on March 21, 1949, Secretary Newcomb pointed out the need of new and younger men as members of the Board of Directors and Board of Grants. The Secretary pointed out that many of those now serving would not, because of age limitations, be able to serve for many more years, and that it was essential that new manpower be brought into the official family of the Foundation.

Dr. Newcomb expressed the view that the Board of Directors should be enlarged so as to enable a larger number of interested persons to play a more active part in the work of the Foundation.

Secretary Newcomb's general proposal was favorably commented upon. President Doerr requested the Nominating Committee of Swain, Chairman, Dunning and Little to give careful consideration to the entire subject of Foundation personnel and its future progress and development. He requested the Committee to bring in a full report on these subjects at the next Annual Meeting.

At the Annual Meeting of the Board of Directors held on April 14, 1949, important changes were made in the official family of the Foundation. Mr. George V. Doerr, who had served as President efficiently and well for a period of six years, insisted upon being relieved of the responsibilities of that office. Mr. Charles S. Beardsley, one of the founders of the Foundation, who had served as Vice-President since the time of its organization, was elevated to the Presidency and is still rendering efficient, unselfish service in that capacity. Director H. Evert Kendig was elected Vice President.

At this meeting \$5,000 was appropriated toward making up any deficit which might be incurred by the American Journal of Pharmaceutical Education. A fund of \$6,000 was also set aside for the American Association of Colleges of Pharmacy for use in defraying the expenses of a Summer Seminar, with the understanding that any unused balance would be returned to the Foundation.

In this budget were also included \$20,000 for undergraduate scholarships, \$100,000 for domestic graduate Fellowships, and \$15,000 for foreign graduate Fellowships.

This budget of \$172,125 represents a mature, useful Foundation in full operation. At the May 26, 1949 meeting of the Board of Grants we find, in addition to the usual important routine business the following action:

"The Board recognized that many questions concerning the awarding of Fellowships come up intermittently between meetings, which require prompt action. Therefore, Chairman Ford was authorized to act on such interim cases on behalf of the Board."

The decision has greatly facilitated the efficient operation of the Board of Grants.

At the Annual Meeting of the Board of Directors held on April 24, 1950, Dr. H. A. B. Dunning was elected Vice President

to succeed Dr. H. Evert Kendig, who had served the Foundation in various capacities since the time of its inception.

At this same meeting, on recommendation of a committee made up of H. A. B. Dunning, Ernest Little and Robert L. Swain, Chairman, the By-Laws were amended making it possible to increase the membership of the Board of Directors to a maximum of twenty-five.

This amendment also provided that the American Association of Colleges of Pharmacy should have five representatives on the Board of Directors, one of whom must be the Chairman of the Executive Committee and one the Secretary-Treasurer of that Association. The amendment further provided that in addition to the fourteen Association representatives on the Board of Directors, the remaining members, a maximum of eleven in number, shall be elected irrespective of their affiliation with one or more of the member Associations.

It was believed that this increased membership on the governing body of the Foundation would result in greater interest in its activities on the part of the drug industry. Indications are that such will be the case.

In accordance with the above amendments, six new members were added to the Board of Directors at a special meeting of Members held on November 17, 1950. They were Mr. Alvin G. Brush, Dr. J. Mark Hiebert, Mr. Eli Lilly and Mr. John G. Searle, as Members-at-Large, and Dean Hugo H. Schaefer and Professor Louis C. Zopf, as representatives of the American Association of Colleges of Pharmacy. These additions brought the membership of the Board of Directors to eighteen in number. Seven additional "Members-at-Large" might still be elected.

On September 1, 1950 the Foundation sustained a most profound loss in the death of its Secretary and Managing Director, Dr. Edwin L. Newcomb. It will prove difficult to replace so faithful a servant, but we may rest assured that his example and sacrifices will not have been in vain. Willing hands will come forward to take up the torch he was forced to lay down. The American Foundation for Pharmaceutical Education will continue to grow and properly expand its area of service.

In the few years of its existence, less than a decade, the Foundation has developed into one of the most significant organizations in the over-all profession of pharmacy. It has helped worthy colleges of pharmacy through the war emergency by direct financial assistance. It has supported undergraduate scholarships, created graduate Fellowships to encourage graduate work of high quality and furnish both pharmaceutical industry and our colleges of pharmacy with much needed men of Ph.D. training. Over one hundred such Fellowships are now being maintained at an expense of about \$140,000 a year.

The Foundation is supporting the American Council on Pharmaceutical Education by an annual contribution of \$20,000. The essentiality of a strong accrediting agency in maintaining high standards of professional education is widely recognized. The Foundation is pleased to play an important part in the maintenance of such an agency.

The Foundation made American Association of Colleges of Pharmacy Summer Seminars possible, as a means of keeping the staff members of our colleges of pharmacy up to date and abreast of new developments in their professional field.

The Foundation contributes \$5,000 annually toward meeting deficits of the American Journal of Pharmaceutical Education. This Journal, under the able leadership of its Editor, Dr. Rufus A. Lyman, is rendering a real service to pharmacy. It is the only Journal in the world devoted exclusively to pharmaceutical education and should be sustained.

The Foundation made possible the Survey of American Pharmacy. It has contributed liberally to the development of pharmacy predicative and achievement tests, and has supported other projects of fundamental importance to the profession.

There are other important responsibilities confronting the Foundation which it has not yet been able to accept. Increased contributions would enable it to operate much more effectively than is now possible. In the meantime, the Foundation will continue to make full use of the tools already placed at its disposal, believing that as its services expand, adequate financial support will be forthcoming.

The men more intimately associated with the activities of the Foundation are also eager for its success for reasons quite apart from those mentioned above.

The formation and successful operation of the American Foundation for Pharmaceutical Education should not only prove a source of encouragement to pharmaceutical educators, but a reassurance to everyone engaged in the various branches of the profession of pharmacy.

It indicates that the over-all profession of pharmacy can operate cooperatively for the good of the whole. It demonstrates that we have at last recognized and accepted the fact that the common interests of the profession are more significant and fundamental than differences which have existed, and probably always will exist between groups engaged in the different branches of pharmacy and the drug industry.

Recent developments clearly indicate that workers in the field of pharmacy are seeking to discover all the interests which its various branches have in common, and with these as a basis, go forward with a united front in the interest of pharmacy as a whole. It is only by so doing that substantial progress can be made. No profession should expect to command respect from the outside until it has obtained internal harmony, and a properly coordinated endeavor to minister to its own needs.

The successful operation of the American Foundation for Pharmaceutical Education is an indication that the above objectives are being achieved. Much still remains to be done, but willing workers stand ready to help achieve the goals for which we are striving.

The Foundation is now located in its new home at 1450 Broadway, New York 18, N. Y. A new full-time Executive Director, Dr. W. Paul Briggs, was appointed at the annual meeting held in New York City on May 17, 1951. Dr. Briggs is unusually well prepared for this most important responsibility.

Five new Directors and a new member of the Board of Grants were also added to the official staff of the Foundation at the May 17 meeting.

The personnel of the Foundation, as of June 1, 1951 is as follows:

Association Members

American Association of Colleges of Pharmacy
 American Drug Manufacturers' Association
 American Pharmaceutical Association
 American Pharmaceutical Manufacturers' Association
 Federal Wholesale Druggists' Association
 National Association of Boards of Pharmacy
 National Association of Chain Drug Stores
 National Association of Retail Druggists
 National Wholesale Druggists' Association
 The Proprietary Association

Officers

President.....Charles S. Beardsley
 Vice-President.....H. A. B. Dunning
 Treasurer.....Hugo H. Schaefer
 Counsel.....James F. Hoge
 Secretary and Exec. Director.....W. Paul Briggs

Board of Directors

Charles S. Beardsley	J. Preston Levis	James J. Kerrigan
Edgar S. Bellis	Eli Lilly	George F. Smith
Alvin G. Brush	Howard C. Newton	Robert L. Swain
Joseph B. Burt	S. B. Penick, Sr.	Ernest H. Volwiler
George V. Doerr	Hugo H. Schaefer	C. R. Walgreen, Jr.
H. A. B. Dunning	R. C. Schlotterer	George L. Webster
Howard B. Fonda	John G. Searle	C. S. Willingham
J. Mark Hiebert		Louis C. Zopf

Executive Committee

Charles S. Beardsley	Howard C. Newton
George V. Doerr	*Hugo H. Schaefer, Treasurer
H. A. B. Dunning	Robert L. Swain
	*W. Paul Briggs, Secy. and Exec. Director

*Members Ex-Officio, without vote.

Finance Committee

Charles S. Beardsley
 James F. Hoge
 Hugo H. Schaefer, Chairman

Board of Grants

A. J. Brumbaugh
 James Hill
 Ernest Little
 Charles J. Lynn
 Guy Stanton Ford, Chairman

These are the men who have accepted the responsibility of guiding the Foundation in the days which lie ahead. Under their leadership the American Foundation for Pharmaceutical Education

is looking forward to a period of greater service than it has so far enjoyed.

May we all play our full parts in helping to make it the instrument of service which its founders intended it to be.

The Immediate Years Ahead*

HUGO H. SCHAEFER

President, American Association of Colleges of Pharmacy

I feel certain that all of us who are entrusted with the training, education and licensure of pharmacists are again looking forward with great concern to what the next few years may bring us. We all well remember the difficult problems which we had to meet and surmount during the recent war years. Fortunately, we successfully outlived that period without any serious breakdown of our professional and educational standards. While our status may have remained static during those years, yet the increased acceleration of progress in the immediate post-war years more than made up for this delay.

The advances made in all phases of our profession during the years 1945-1951 gave real promise of representing the beginning of a march of progress which would bring pharmacy to its rightful place in the field of health services. These advances were evident in all branches of our rather complex structure. We who are gathered here are, of course, primarily interested in education and licensure. During the past few years great strides have been made in these fields. The faculties of our colleges of pharmacy have been greatly strengthened, courses revised and improved and a real start has been made in lengthening the time of study from four to five and even six years. Probably never before in a like period of time have the physical facilities of our schools been so greatly improved. Several completely new college buildings have been erected and many of our older schools have been enlarged and modernized.

*Read before District No. 2 at the 1951 meeting.

A general policy of carefully screening the applicants for admission has been adopted and no longer may any and every high school graduate study pharmacy. Only those with superior ability and suitable background are accepted. The American Foundation for Pharmaceutical Education has greatly stimulated graduate work in our colleges which is beginning to promise an adequate supply of new and well-trained teachers. This organization has also made it possible for the American Council on Pharmaceutical Education to make a much needed review of the standards of accreditation and to classify the colleges. This has been a strong influence for the betterment and strengthening of the national structure of professional education for pharmacy. Thus we have today a far better type of young person entering the ranks of pharmacy than ever before, one of superior intellect, training and education.

The boards of pharmacy of the different states deserve considerable credit for these advances in our field of education. They have actively supported every forward step and given their cooperation to the fullest extent. In matters of education they can be considered the cushion in thought between the colleges and the retail pharmacists and have served well as a balance wheel between these two groups. This is particularly important since retail pharmacists are often somewhat hesitant in favoring educational requirements beyond those which they themselves enjoyed. They are inclined to consider longer and more intensive courses as leading to a shortage of pharmacists with a resulting increase in salaries. The boards are a vital influence in obtaining retail pharmacy acceptance of progressing educational requirements. Their wholehearted support is best evidenced by the changing nature of the board examinations themselves. One need only compare the questions of an examination of ten years ago with those of today to realize that the boards are fully aware of the fact that higher educational standards are a present day necessity.

But pharmaceutical education and licensure is only one small segment in the broad field of drug distribution. It is fortunate to note that these last few years have also witnesses corresponding progress in other divisions of pharmacy. There has been a vast impetus to research particularly in industry. Never before in a like period of time have so many valuable and revolutionary rem-

edial agents been developed by our pharmaceutical manufacturers. One need merely cite the antibiotics as an example. While penicillin was used during the recent war yet we now see that its discovery was merely the forerunner to a whole field of such drugs more recently developed during the peace years. The number of lives which will be saved by the use of these drugs, I prophesy, will far outnumber any death toll taken by the military use of the dreadful and much publicized atom bomb.

Another group which represents an essential part of our drug distribution industry is that of the wholesaler. Its members are successfully meeting the problem of rapidly increasing overhead by using more efficient and modern operational procedures. It is particularly pleasing to note the interest of the wholesalers in establishing courses of sales lectures and pharmacy administration procedures. No longer are they satisfied to merely sell to the retailer but they are giving time, effort and money to enable the little druggist to better display his merchandise and to help him to increase his volume.

One need only to look around to see the great strides made by retail pharmacy itself. Many millions of dollars have been expended during the recent peace years in modernizing and improving the appearance of our drug stores. The pharmacy of today is a bright, well arranged establishment with modern fixtures and well displayed stock and provided with an efficient and well equipped prescription department. There has been a definite tendency towards the elimination of luncheonette and soda departments. The adoption of shorter hours of operation has become a general rule. The number of prescriptions compounded has increased considerably and pharmacists have become definitely aware of the fact that they are entitled to adequate compensation for professional services. The average yearly net profit of drug stores has increased greatly and salaries for registered pharmacists are quite attractive today. Whereas young people before the recent world war were reluctant to choose pharmacy as their career we now have a condition where our colleges have many more applicants than they can possibly accept.

These economic improvements in retail pharmacy have also served to give the members of the profession a great uplift in

morale. Today it is the exception rather than the former rule for a pharmacist to depreciate his profession. Pharmacists' sons and daughters to an ever increasing degree are entering into their fathers' profession.

This better spirit and greater interest in the profession has also resulted in pharmacists becoming more active in organizational work. Our retail organizations today, national, states and local have a vastly greater combined membership than ever before and the attendance at meetings and conventions shows the great interest which pharmacists have in the work of their organizations.

In my opinion there has also been an improvement in our public relation. We are receiving a more general recognition of our professional status not only by the general public, but also by governmental agencies and by the medical profession itself. This is the natural consequence of having higher educational standards, better appearing and more efficiently conducted pharmacies as well as the wide publicity given by the public press to the discovery of the many new miraculous remedial agents which have made the public definitely drug conscious.

Yes, pharmacy has made great strides during the last decade both economically and professionally. But what about the future? Many fear that once again we are facing a great national crisis. The world is divided into two armed camps of peoples and we are opposed by a powerful and ruthless foe whose leaders are intent on destroying our form of government and foisting their foreign ideologies upon us. It is a foregone conclusion that if we must fight to preserve our freedom we will do so even to the last dollar and the last man.

In view of the tremendous stakes in the present conflict of ideas it is idle to believe even if we do not have a world war that the present period of tension will be of short duration. The only prudent assumption is that we will have a long and costly period of armed mobilization and that before it is over, it will call for the enlistment of every able-bodied man and woman either in the fighting army or in the working army. We are confronted with an enormous tax program, shortages of drugs and merchandise, longer hours of work and a lack of manpower. Professional help will be harder to get and profits, at the best, will be uncertain.

The colleges too face great difficulties and a possible return to the conditions which prevailed during the last war. Student enrollment will be greatly decreased, costs of operation will be much higher and many of the best qualified teachers will be tempted to enter industry.

What are we doing about all this? Should we not have a planned program to meet these changing conditions in a realistic but orderly way? At the conclusion of the last war we were enthusiastic and energetic in meeting the challenge of the new era. The term "post-war period" became a popular phrase and many papers were written on that subject. The entire program of conventions were devoted to discussing and planning how pharmacy could grow and prosper during the peace years. Should we not now again lay plans to prepare us to meet the impact of the present dire situation?

To prophecy is always hazardous. Predictions of what may happen in the future and how to meet these happenings must be the result of searching study and calm thinking. We should try to avoid any feeling of hysteria or emotional impulses. Likewise we must avoid an attitude of listlessness and discouragement in considering the future of pharmacy. Our profession may be of little significance and import as related to the great political and economic world changes which we are undergoing, but such comparisons only lead to defeatism and furnish us with an unconscious excuse to sit back and do nothing.

Are we not too apathetical about the present situation? Are we not in danger of losing our recent gains? There is, of course, little that we can do as individuals other than to act as loyal citizens freely and ungrudgingly accepting the sacrifices which must be made. Such sacrifices are great but will be met alike by citizens in all walks of life. We however who hold positions of leadership in our pharmaceutical organizations must plan for the future not only to retain our gains but to insure still further progress in the advance of pharmacy. If these are times of sacrifice and of fear, they are also times of opportunity. We now face a challenge which can only be met by imaginative concepts, capable of development into constructive accomplishments.

It appears to me that we need a greater realization of our immediate problems. These I state as follows:

1. We must continue to strive for higher educational standards.
2. We must actively oppose any attempts to reduce the standards of licensure under the pretense of an expected registered manpower shortage.
3. We must devise a program of giving fair and equitable credit for experience in the armed forces.
4. We must continue working for greater recognition of pharmacy personnel in the armed forces.
5. We must oppose any tendency for having governmental bureaucratic control over pharmacy or any other branch of the health professions.
6. We must work for a program of draft deferment for a sufficient number of registered pharmacists to insure the continuation of essential health services.
7. We must work for an equitable program of deferment of a sufficient number of pharmacy students to provide an adequate future supply of registered men commensurate with the interests of public health.
8. We must actively favor a tax program which does not unduly raise the cost of essential medical care.
9. We must aggressively seek representation for pharmacy in governmental agencies.
10. We must continue to find means to limit the sale of drug products to pharmacies.
11. We must more strongly oppose the present tendency to establish retail drug stores as departments of super-markets.
12. We must provide for a more effective means of disseminating pharmaceutical health service information to the public and to other health profession groups.
13. We must seek recognition for a proper place for pharmacy in any civil defense program.

We should all work for the accomplishment of these objectives. Economically and professionally we are far stronger than at the outbreak of World War II. We survived that period and I feel certain that with our increased strength and standing we can successfully meet anything the future may bring provided we all do our utmost in preserving the rights and privileges of our profession.

Where Will They Find Jobs*

ROBERT P. FISCHELIS

Secretary, American Pharmaceutical Association

Mr. President and Members of the American Association of Colleges of Pharmacy: If I may be permitted to speak extemporaneously and, perhaps, to report some conversations I have had, from time to time, with officials in various agencies of the Government requiring the services of pharmacists and with the heads of non-governmental agencies and organizations who need pharmacists, I would prefer that to presenting a formal paper.

The Office of Education of the Federal Security Agency very recently issued a bulletin in which it was pointed out that 1950 will probably be the peak year for GI graduates. They expect the total number of bachelor or first professional degrees to be awarded for the term 1949-1950 to reach 428,000. There will be 62,000 master's degrees and 6900 doctorates. These degrees will be conferred by more than 1250 institutions throughout the United States. For 1950-51, the number of undergraduate degrees is expected to be less, but the number of graduate degrees is expected to increase.

I mention these general statistics because you know what the figures are for pharmacy colleges and, whether we realize it or not, some of our pharmacy graduates are going to be in competition for some positions with holders of bachelor degrees from other departments of universities. This is so because some positions which have previously been filled by pharmacists, because of their professional backgrounds, will now perhaps be filled by non-pharmaceutically trained graduates who have specialized in certain phases of public health work or medical technology. Pharmacy needs to be alerted to the problems of maintaining its status with respect to the positions which pharmacists have been filling, but which do not necessarily require college training in pharmacy.

As an illustration of the kind of interest the Federal Government has in graduates of colleges of pharmacy for the future, I would like to call attention to a notice which has just been re-

*Presented before a general session of the American Association of Colleges of Pharmacy at the 1950 meeting at Atlantic City.

ceived from the Division of International Health of the U. S. Public Health Service, in which it is pointed out that to meet the increased demand for experienced health personnel to staff technical health missions overseas, which have been authorized by Congress, the Public Health Service is developing an intensive recruiting program.

Opportunities for overseas assignments in the higher grades are expected to develop for a number of physicians, dentists, pharmacists, scientists, health educators, sanitary engineers, sanitarians, nurses, administrators, and technicians. Some of the projects will involve employment by the Public Health Service, and some will involve employment by the World Health Organization.

Members of technical missions can assist foreign governments in establishing public health training, initiate health demonstrations, supervise specific projects, and serve in an advisory capacity to foreign government officials on health matters.

The various overseas health missions of the United States have been authorized by Congress with a view to strengthening mutual understanding between the people of the United States and the people of other countries. Such missions offer a challenge to American health experts to cooperate with the other people of the world in the development of human resources, as well as an opportunity to broaden their own medical and personal horizons.

Recruitments will be limited to highly qualified personnel, possessing both expert knowledge in their technical specialties, and the ability to inspire cooperation in a constructive program directed toward broad improvements in public health and the general advancement of human relationships.

Assignment will be made in the higher grades. Additional compensation will be provided in the form of allowances for overseas services.

Qualified health personnel may obtain application forms and further information to participate in these programs by writing to the Chief of the Division of International Health, Public Health Service, Federal Security Agency, in Washington, D. C.

Supplementing the foregoing general notice, I was called on the telephone to be advised that there are some specific places for

pharmacists in these missions, and that the Division referred to is very anxious to enlist the aid, in its recruitment program, of the colleges of pharmacy which have placement services.

The answer to the question "Where Will They Find Jobs?" divides itself into several sub-divisions. We are all greatly interested in training men and women for positions in retail pharmacy and in hospital pharmacy. That is perhaps where the majority of our graduates will finally land.

It has been roughly estimated that all the graduates of 1950 and, perhaps also the graduates of 1951, will be needed to fill the vacancies which exist in various states because of the retirement of many pharmacists who would have retired some years ago, if there had been an adequate number of replacements. It is interesting to compare the situation in various states.

For example, in the State of Maine and some other New England states, the average age of the pharmacists in retail practice is well over fifty; whereas in some of the Western states, like California and other Pacific Coast states, the average age is below forty.

There has been a migration of the younger group of our profession, as there has been in others, to the Western states. Latest census figures point to the fact that some of our Eastern states are going to lose congressmen in the new apportionment which is expected, whereas some Western states will increase their number of representatives in Congress, because of the shift in population. It seems clear that our younger pharmacists are moving to places where they feel that they will have better opportunities.

The newly created Commission on Professional Manpower for Pharmacy hopes to conduct studies in this field, so as to be able to provide helpful information on the supply and demand for pharmacists to all concerned.

Coming down to specific cases of where jobs can be found for pharmacists interested in careers other than the retail drug business, let me cite first the armed forces and the U. S. Public Health Service as agencies which are now actively recruiting pharmacists. Some of their representatives, as you know, have visited you, and they have endeavored to enlist your interest in selecting able young men and women to take permanent positions in the

Army, the Navy, the Air Force, and in the Public Health Service. Other governmental agencies are also looking for good pharmacists.

The future status of pharmacy in these agencies will depend, to a very large degree, on whether they will be able to find, among recent graduates, people who can fill these positions acceptably. At the moment, the Army, for example, still insists that its over-all medical supply work shall be headed by a physician, even though it is quite readily admitted that pharmacy training is a much better background for this type of work than training in medicine.

But, up to now, we have not had the show of interest on the part of the young pharmacists to enter the military service during times of peace as a permanent career, that we think we should have. We hope the faculties of colleges of pharmacy will keep their eyes on able young men in their graduating classes who can fill these places. Obviously, if we are not able to supply such men in times of peace, we will not build up a nucleus for the enlargement of the pharmacy service in time of war.

It is during peace periods that services are designed and preparation for expansion is made. If medical and other officers have to shoulder that responsibility in peace times, they will be the ones who must be relied on to look after the expansion of the service, if necessary, in times of emergency.

I cannot over-emphasize the importance of supplying adequate numbers of young pharmacists for these services. The argument is often heard that our graduates in pharmacy can now expect better financial returns from the practice of pharmacy in retail stores, than they can in the Government service, but there are compensations in the Government service which will attract many people, and which should attract some of the better graduates.

In a recent conversation with officers of the Public Health Service who are engaged in an expansion of hospital activities throughout the United States, some unusual opportunities were pointed out for pharmacists. I think all of you know that, under the Hill-Burton Act, many hospitals are being organized in very small communities. These hospitals run anywhere from 25 beds up, and we have many communities with 25-, 50-, and less than 100 bed hospitals, now realizing for the first time that after you

get the Government to aid to build these hospitals, you still have to have ways and means of supporting these institutions, in order to give the service they are supposed to render. Of course, one of the most difficult things they have to contend with is acquiring properly trained personnel. The hospitals are too small in many cases to employ a full-time trained administrator, or a full-time laboratory, X-ray, pharmacist or other auxiliary service chief.

This offers an unusual opportunity for the employment of pharmacists, and I think it shows the extent to which it becomes necessary to diversify the elective part of the curriculum of colleges of pharmacy.

It has been suggested, for example, that some of the communities which have small hospitals, but do not have sufficient need for a well-organized pharmacy department in charge of a pharmacist, may want to combine certain duties and create a full-time position for a competent person. Pharmaceutical service is necessary and, if the pharmacist is in a position to render professional or administrative services in addition to compounding prescriptions, he could grow into a position of considerable prominence in some of these institutions.

Some of these new hospitals have considered calling upon county superintendents of public instruction to act as superintendents of their hospitals, on a part-time basis. How much better it would be to call on a competent pharmacist to set up an adequate pharmacy service in such a hospital and also take over administrative duties. It is also a simple matter for hospitals of this kind to call upon their pharmacist to do the laboratory work and act as x-ray technicians and furnish other professional services for which they have been trained.

So the field of service of the pharmacist can expand considerably if we keep in mind that there is just as great an opportunity for him or her to utilize knowledge and training which can be acquired in a college of pharmacy for professional application as there is for its commercial application.

Acquiring broadly trained personnel is a rather serious matter with the Public Health Service at the moment, because it is being asked to supply qualified people for positions in these new community hospitals.

To my mind, it is one of the most promising types of openings we have for those who intend primarily to devote themselves to the practice of pharmacy and related medical care services, and who are not primarily interested in acquiring a retail drug business.

As far as opportunities in hospital pharmacy are concerned, you will be interested to learn that the American Hospital Association, through its Council on Professional Practice, has approved a set of minimum standards for pharmacies in hospitals, which give the pharmacist a very prominent place in the development of the hospital supply service, as well as the pharmacy itself.

With the adoption of the standards fostered by the Division of Hospital Pharmacy of the American Pharmaceutical Association and their approval by the American Hospital Association, it is expected that the American College of Surgeons and the American Medical Association will also give them their endorsement. This will make it necessary for hospitals recognized for internship to have a well-developed pharmacy department in charge of full-time pharmacists.

It was not very long ago when we had less than 1000 pharmacists in hospital positions. We estimate, at the present time, that there are close to 2000 on full-time service and that there is a distinct possibility for double that number to be placed very soon, provided there are men and women competent and prepared to give the quality of service demanded in the minimum standards.

So, hospital pharmacy offers a very distinct and constantly expanding field for more of your graduates.

The adequate enforcement of state pharmacy laws will also increase the demand for pharmacists. It is very disconcerting to note developments in some places, where there has been a shortage of pharmacists, to permit a pharmacy to segregate its prescription department and to close it off from the rest of the establishment, so that a registered pharmacist need not be in charge of the entire establishment at all times.

This is a development which should definitely be discouraged by everyone who is interested in promoting the interests of pharmacy and the public health. Every effort should be directed in an entirely different direction, namely, to strict enforcement of State pharmacy acts.

If pharmacy laws were strictly enforced, it would be necessary to employ at least 20,000 additional pharmacists in the United States, according to figures which have been developed in recent years.

That demand will not be satisfied for some years. Unless we insist on adequate enforcement of State pharmacy acts, we are not in a position to go to the public any longer and say that pharmacists are in charge of pharmacies at all times. If we condone the closing of drug departments in pharmacies for a portion of the day, and continue to display drug signs over the door and windows, we are not playing fair with the public. The average citizen feels, when he enters a drug store and sees the sign "Drugs" above it, that his government has, in some way, provided that pharmaceutical service will be available there at all times. I think it is entirely fair to say that adequate enforcement of the pharmacy acts which are now on our statute books, not the addition of any new ones, will definitely increase the demand for pharmacists.

Lastly, the drug industry is very much interested in adding to its staffs, men and women with a pharmaceutical background. Only a few days ago, a very prominent manufacturer in conversation with us bemoaned the fact that he was unable to secure for his laboratory and for his product development department, bachelors of science who had a background in pharmacy. He deplored the fact that he had to go into other fields, such as chemistry and the biological sciences and bacteriology, to find people who would do work which he would rather have somebody with a pharmaceutical background perform.

The detail forces of some of our manufacturing houses are now composed almost exclusively of graduates in pharmacy, and they are not, by any means, satisfying the demand. More and more of the pharmaceutical houses are expanding their detail work, because it has been definitely demonstrated that the way to promote new pharmaceutical products is by personal contact with the physician. More of our young men and, in some instances, women are being sought for product promotion work with physicians.

From the place where I sit in American pharmacy, I see no need for apprehension about the number of graduates anticipated in the near future, provided we are going to do some of the things I

have alluded to. If we are just going to sit tight and not concern ourselves about arranging to fill the places which are opening up to our graduates, by paying some attention to channeling people into well conducted elective courses which will help them to prepare for these opportunities, obviously we are not going to be able to fill them. Some of these jobs will go to other bachelors of science, because, as I indicated at the beginning, many thousands of well trained prospective scientists are being produced. Many of those who are preparing for medicine, and are unable to get into medicine, will want to go into something related thereto. Some will take up pharmacy. Others will take jobs that do not require a pharmacist's license, but should require a pharmaceutical education.

It seems to me that pharmaceutical educators have a responsibility in helping their graduates to find the right place for the employment of their talents and training. At the moment, the available manpower in pharmacy does not seem to exceed the expanding demand to any appreciable extent.

Precision in Beginning Courses in Quantitative Analysis

MELVIN W. GREEN*

University of Wisconsin, School of Pharmacy

The problem of what precision to expect of beginning students in quantitative analysis always has been a vexing one. Frequently teachers have observed replicate results in which the average is close to the expected value, but the precision is very poor. If too much pressure is put on the student to improve his precision, he often does so by the "graphite-cellulose" method since he can change his results regarding precision but he usually has no way of altering his accuracy without guessing. This is further complicated by the fact that the established precision of various methods are usually predicated upon experience.

*The author wishes to acknowledge the assistance of messers Aaron Cooper and John Lach in collecting this data.

The author has been trying a method of establishing precisions by the students themselves. The method is based upon standard statistical practices and, in effect, depends upon the use of the standard deviation, although with simplified calculations.

Statistically it is recognized that in any series of measurements, deviations from the average figure is meaningless, but that the standard deviation, which is the sum of the deviations squared and divided by the degrees of freedom, can be interpreted more satisfactorily. Furthermore, it can be stated with assurance that one should expect about two-thirds of all data to be within the limits of the average figure \pm one standard deviation unit, about 95 per cent of the data should fall within \pm two standard deviation units and better than 99 per cent of the data should be within \pm three standard deviation units.

Since analytical data are expressed commonly to four decimal places, a calculation involving squares and square-roots becomes very cumbersome, especially when handling large amounts of student data. During recent years it has been recognized that when dealing with small samples, the range (the largest minus the smallest) is a measure of the dispersion as sensitive as the standard deviation and in fact related to it. This fact is the basis for statistical quality control in industry.

In a student laboratory, it is common to have many unknown samples whose values are known with some accuracy to the instructor. To collect and evaluate the data from such samples, it is necessary to express the accuracy in terms of the deviation from the known value. This makes it possible to compare the results of all students making the same determination even though different samples are used. In our laboratory the students run all determinations in triplicate, hence the calculations will be demonstrated on this basis.

First typical student values must be obtained. As each student turns in his results, record the deviation of his average from the known value and record the range (the highest minus the lowest of the three data). After the data from the entire class has been tabulated, calculate the grand average deviation (\bar{X}) and the grand average range (\bar{R}). The average range, \bar{R} , is a valuable parameter from which a sound estimate of the standard deviation

from a very large number of subgroups can be obtained. It is accepted that for subgroups of three, the ratio of the average range and the standard deviation is 1.69 and this ratio is customarily given the symbol d_2 (1). The estimated standard deviation is then calculated by dividing the average range by d_2 (in this case 1.69). This measures the spread of individuals, however.

Averages can be expected to deviate within three times the standard error of averages (mean), this latter value being the standard deviation divided by the square root of the sample size, n . Tables are available which avoid these calculations by relating the range to the limits (statistically termed 3-sigma limits) directly. For subgroups of three, this value (in tables symbolized A_2) is 1.02. Therefore, if one multiplies the average range by 1.02 the dispersion of average deviations is obtained. This value added to and subtracted from the grand average of the class gives the upper and lower limits of average deviations from the known value to expect if the work is in control. When the average of any student's values goes beyond these limits, his accuracy in relation to his fellow students is sufficiently low that he should repeat the experiment.

Since standard deviations of subgroups, and hence ranges, are dispersed around the grand average of such ranges, the same statistical laws apply. For small subgroups the lower limit for the ranges is obviously zero and the upper limit may be obtained by multiplying the tabular value D_4 (again derived from ratios which convert to standard deviation units). For subgroups of three, D_4 is 2.57, i.e., the upper limit for ranges is $2.57\bar{R}$. Table I gives the value of d_2 , A_2 , and D_4 for replicates of 2, 3, 4, and 5.

TABLE I

Replicate Size	d_2	A_2	D_4
2	1.128	1.88	3.27
3	1.693	1.02	2.57
4	2.059	0.73	2.28
5	2.326	0.58	2.11

The utility of this method can be illustrated by the alkalimetric determination of the purity of sodium carbonate using values ob-

tained from 78 students. The determinations were made on 8 different samples. The average deviation from known values was 0.36 per cent and the average of the ranges was 0.42, expressed in percentage units. To find the limit for average deviations, multiply the range by A_2 , i.e., $0.42 \times 1.02 = 0.43$. This value added to the grand average is 0.79, the upper limit for averages. That is, any student average which exceeds this value is completely out of control in relation to the other students. There were two such values in this lot of 78. Obviously there should be no lower limit on accuracy.

The upper limit for ranges should be D_4R or $0.42 \times 2.57 = 1.08$. If the range of the triplicate results of any students exceeds 1.08 (in percentage units) his precision is so poor that he should receive no credit for the determination and should repeat the experiment. There were three such cases in the group of 78 reported. The value of this finding lies in the knowledge that the precision of these three students lies far beyond that of the rest of the class and is being set by his fellow-students and not by experts. Table II shows the ranges, average deviations, limits on accuracy and on precision of several typical laboratory experiments as well as the number of cases exceeding the limits. The number of students involved in the different determinations ranged from 70 to 90.

TABLE II

ANALYSIS OF SOME TYPICAL STUDENT DATA

Reaction	average	range	limit of average	limit of range	Number beyond limit on accuracy precision	
Soda ash titration.....	0.36	0.42	0.79	1.08	2	3
Volhard chloride	0.40	0.40	0.81	1.03	3	6
KH Phthalate Titration.....	0.25	0.28	0.54	0.72	1	4
Dichromate titration of						
Ferrous sulfate	0.22	0.10	0.32	0.26	10	2
Permanganate titration of						
sod. oxalate	0.17	0.21	0.38	0.54	3	1
Iodimetric titration of						
arsenic oxide	0.25	0.24	0.49	0.62	6	5
Gravimetric sulfate	0.49	0.48	0.99	1.23	4	6
Gravimetric chloride	0.21	0.27	0.54	0.69	0	3

Many teachers do not believe that too much emphasis should be placed on precision at the beginning level, but rather the stress should be on accuracy and that the precision will come later as experience increases. This method allows one to segregate quickly the least precise for action. If one wishes to grade on precision, it is a simple matter to establish levels of R in relation to the standard deviation and develop a grading table. This is described below.

Statistical tables are available which relate the fraction or the multiple of the standard deviation unit to the area under the probability curve. For example, 0.25 of a standard deviation unit is represented by 19.6 per cent of the area, and 1.5 standard deviation unit represents 86.6 per cent of the area according to standard tables. The instructor can determine what percentage of his class should receive a particular grade. Since the majority of grades should be "C", standard deviation units can be picked to throw the majority of grades in the upper 70's and lower 80's. Since the standard deviation is related to the average range by being equal to \bar{R}/d^2 , the standard deviation can be related to \bar{R} in such a table.

In a given determination, the ranges obtained by individual students are assumed to be dispersed about the average range in the normal manner. This is not strictly true, but appears to be true enough for our purpose. On these assumptions, a table was constructed of grades (related to the area under the distribution curve) and a Range Factor, i.e., the multiplier of the average range \bar{R} . These values are found in Table III. Table III serves then, as the master table for determining grades for individual analytical determinations. For example the Range Factors for the grade of 78 per cent is 0.85 to 1.27 ($n = 3$).

TABLE III
RANGE FACTORS AND GRADES

Range Fractor $n = 2$	Range Fractor $n = 3$	Grade %
0.0 -0.57	0.0 -0.087	98
0.058-0.11	0.088-0.17	96
0.12 -0.17	0.18 -0.25	92

0.18 -0.19	0.26- 0.29	88
0.20 -0.28	0.30 -0.34	86
0.23 -0.26	0.35 -0.39	84
0.27 -0.28	0.40 -0.43	82
0.29 -0.55	0.44 -0.84	80
0.56 -0.84	0.84 -1.27	78
0.85 -1.13	1.28 -1.72	76
1.14 -1.23	1.73 -1.86	74
1.24 -1.35	1.87 -2.04	72
1.36 -1.45	2.05 -2.20	70
1.46 -1.56	2.21 -2.37	68
1.57 -1.68	2.38 -2.54	66
1.69 -1.79	2.55 -2.71	64
1.80 -1.90	2.72 -2.88	62
1.91 -2.00	2.89 -3.04	60
2.01 -2.13	3.05 -3.22	55
2.14+	3.23+	50

In the case of the titration of potassium acid phthalate, the average range (\bar{R}) for the classes was found to be 0.28. Multiplying the average range by the Range Factor gives an actual range for this grade of 78 per cent of 0.24 to 0.35, ie., any student having a range of a triplicate determination between 0.24 and 0.35 (in percentage units) would receive a grade of 78 per cent for precision only. The instructor can then integrate this grade with one based on accuracy only in any way deemed proper. Table III contains also Range Factors for a subgroup of two for cases where the determination is made in duplicate.

To simplify, grading tables have been established for each determination in the course showing the ranges applying to each percentage and related to the class average determined from previous classes. As more data accumulates, it may be desirable to change the average range of that of several classes combined.

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Professional Nomenclature*

CHARLES O. LEE

Purdue University

You who are here today for the first session of this course have chosen pharmacy as the curriculum which you wish to pursue in this university. This is the beginning course in pharmacy which is basic to all of the other courses of pharmacy in the curriculum. The assignments given to you in this class should be learned well.

This course will give consideration to the techniques of pharmacy which will acquaint the student with the many processes peculiar to the profession together with explanations for them. As the course proceeds arithmetic, an understanding of which is so essential to prescription practice, will be presented and discussed. The third feature of the course will be that of nomenclature. This phase of the work will introduce the student to the systems followed in giving names not only to the old but to the new preparations, their endings and word order.

Pharmacy is a profession and, for that reason, has a language of its own. The practice of pharmacy involves techniques which are described in terms known only to the pharmacist. The same may be said for its many definitions, explanations, and descriptions. Moreover, the preparations so well known to pharmacists fall into convenient classes such as waters, solutions, spirits, ointments, and so on. The items which belong to these classes may be listed alphabetically for matters of convenience either by their English names or the Latin.

Professional nomenclature includes learning not only the names peculiar to the profession, but their derivation and meaning also. Correct pronunciation and spelling are a part of the task of learning. For those who have acquired careless habits of speech and spelling the problems of nomenclature become more of a learning task. The English language is not a pure one; it is a conglomerate of several languages. We like to feel that it is essentially rooted in the Latin. Modern scientific and technical names are com-

*The opening lecture on nomenclature to a beginning class in general pharmacy.

monly made up from the Latin and ancient Greek. This confronts the professions of medicine, dentistry, and pharmacy with the necessity of understanding some Latin and Greek as well as the English. To illustrate what I mean, many of the sciences have "ology" as their suffix, namely, biology, zoology, physiology, and pharmacology. The term "ology" stems from the old greek word *logos* (λογος) which is translated in the gospel of St. John as the "word". However, in the Greek its meaning is much more than is implied in *word*. Biology really means a subject which represent the "all in all" of life, broad, comprehensive, and perhaps mysterious. Even the word Pharmacopoeia is derived from two Greek words, (*Pharmakon*, drug, and *poico*, Make).

A more practical illustration of the use of a common term is that of the abbreviation Sig. so well known to pharmacists. It is an abbreviation of "signature" and derives from *signatures* the past participle of *signo*, sign. We interpret it as the directions which are to be put on the label of a prescription.

These few examples are given for the purpose of introducing you to the great task of becoming intelligent about your profession by learning to know the meaning of the terms used in it.

It may be of interest to you to know that the first United States Pharmacopoeia, printed in 1820, was written in two languages, Latin and English. The Latin appeared on the first page of the monograph and was then, apparently, the language of first choice. You can see from this that you are removed from a thorough knowledge of Latin by about a century and a quarter. The Latin text was dropped from the Pharmacopoeia in the revision of 1830. However, the titles of the monographs remained latinized in the Pharmacopoeia until the 12th revision in 1940.

In 1893 Oldberg discussed "The Etymology of the Nomenclature of the United States Pharmacopoeia" (The Apothecary 2:97, Mar. 1893). He found that it took 457 different words to formulate the 997 titles in U. S. Pharmacopoeia of 1880. Of these 457 titles,

- 171 were of Greek origin
- 153 were of Latin origin
- 21 were of Mixed L. and G. origin
- 20 were of Arabic origin
- 45 were from other languages

29 were from names of places

18 were from names of persons.

The present Pharmacopoeia likely would not give us this picture but we might be surprised if we made a similar study of it.

In the U. S. Pharmacopoeia XIII and the National Formulary VIII English was made the language of first choice for all of the official titles. This has relegated Latin to a minor position in our present nomenclature but has not completely eliminated it from consideration in our curriculums. Each of these compendiums has a committee on nomenclature but changes as marked as the one mentioned above should be made by a vote of the respective general committees.

The nomenclature of the sciences allied to pharmacy is rooted mainly in Latin. Because of this it is necessary for us to master certain fragments of Latin as are needed to have a knowledge of the abbreviated titles and the directions which appear on prescriptions from time to time.

Pronunciation

In matters of pronouncing we pharmacists have been much too careless. It is common to hear such words as *digitalis*, *hyoscyamus*, *tragacanth*, *sapo*, *petrolatum*, and many others, mispronounced in English. To add to the confusion of pronouncing both the English and Latin names and titles the so called *Roman Method* of pronouncing is taught in most classes in Latin. Who knows just how the Romans pronounced and if we did know why promote it. In this course it will be our purpose to pronounce all Latin titles after the so called *English Method* which is according to Webster's unabridged dictionary. This should make it clear to you that, while emphasis is being given to the pronunciation of terms new to you, it will be according to the best English that we know and all sounds will be as in English words.

There is this difference between pronouncing English and Latin titles. There are no silent vowels in Latin as there are in English. The word *aloe* is pronounced as al'ō in English but as al'ō ē in Latin.

All words of two syllables are accented on the first syllable. *Sapo* is pronounced sa'po, not sap'o, sul'fur, not sool'fur. There

is not time in this course to give time to orthoepy, the art of correct pronunciation, except as it may be taught by example. This is just a matter of learning to pronounce from the markings of the vowels and syllables of words as given in the standard dictionaries. We will, therefore, spend some time in class repeating aloud lists of titles both in the English and the Latin. This is done for the purpose of getting your ears accustomed to strange sounds of your own and of those around you. Practice of this kind often makes hard words easy.

Words Frequently Mispronounced

The following list of words, picked at random, is an exercise in pronouncing Latinized titles. Please repeat each word after me. Relax, be at ease, and do your best to imitate me. Should I make a mistake we will try to correct it at the time.

1. al-oë not al'ō
2. a'qua not aq'ua (qu = kw)
3. Chenopo'dium (ch = k) not shen.
4. col'chicum (kol'ke kum) not (kol-chee-kum)
(c = sound of k before a, o, u.)
5. li'chen (lai-ken) not (lee-chun or lee-ken)
6. cube'ba (kubē'ba) not cubeb'a.
7. tragacan'that not trajacantha
8. cimicif'uga not cimicifu'ga
9. protococ'co (protokoksai) not (protokokki) (c before e, i, and y has the sound of s)
10. lo'tio (lo'she o) aspirate the ti as she
11. althae'a (althe'a)
12. atropi'na atropi'na not (atropee'na)
13. digita'lis—digitālis or now digital'is
14. gla'bra—glā'bra not glab'ra
15. podophil'lum (podofil'lum) not podoph'yllum
16. erigeron'tis (e-rij-e-ron'tis)—g has the sound of j before e, a, and y.
17. cypripe'dium (sip-re-pe'dum) not (sip're-pe-deum)
18. sto'mata not stomat'a
19. fran'gula not frangū'la
20. hyosey'amus (hai-o-sai'a-mus) not (hai-o-sai-ah'mus)

Exercises in Pronunciation

The markings indicate the accent. Vowels which are marked are pronounced long. Example—Kīno, the i is marked and is accented and pronounced long.

Aca'cia, ace'tum, acet'icum, a'deps, iod'idum, apoc'ynum, caffei'na, citra'ta efferves'cens, can'tharis, corrosi'vum, leucaden'dron, ranuncula'ceae, papa'ver, cambo'gia, cam-phora, acetanili'dum, aconi'tum, morphi'na, arsphenami'na, ipomoe'a (ipomeea) theophylli'na. (Diphthongs ae and oe are pronounced as e).

The discussion up to this point has been comparatively simple in as much as we have dealt with simple words. Latin titles consisting of two or more words make problems for the beginner at two points, namely, the endings and the word order. For example water of camphor is Latinized as aqua camphorae, *aqua* being the Latin word for water. The *ae* on the end of camphor puts it in the genitive case, which in turn gives it the relationship to water as is indicated by the preposition "of." The noun, therefore, which serves to limit or modify has the genitive ending. Aqua is thus limited by camphora hence the genitive ending. In the case of chemical salts the name of the metal is the modifier and is inflected; example sodii chloridum which in English is chloride of sodium.

The Problem of Declensions

You soon will have observed that many titles in pharmacy end in *a*, others end in *e*, *us*, *um*, *er*, *as*, *is*, *io*, *o*, *ma*, *ol*, *al*, *yl*, *on*, *en*, and other endings some of which are classed as irregular. This situation complicates the formation of genitive endings for our official Latin titles but inasmuch as there is a system to it a title can be invented for any good English name. Long, complicated chemical names do however present problems which will be discussed later in your course in organic chemistry.

The system which was just referred to is that of the declensions known as the first, second, third, fourth and fifth. A sixth class comprises those words which are not declinable. We spend no time in this course on declining nouns and adjectives but you who have studied Latin know something about its value in formulating endings. There is time here to learn the endings but not to go into detail concerning them. You will be made aware of them but not much more than that. This should be enough to explain why certain words in the genitive end in *ae*, others in *i* or *ii*, *idis*, *itis*, *atis*, *cis*, *atis*, *mis*, and *nis*. Some endings are the same in the genitive case as in the nominative.

It should be understood also that all official titles are in the nominative case even though certain endings are in the genitive and in a few instances in the ablative case. Many titles are comprised of two and three words all of which have nominative case endings inasmuch as no part of the title is being qualified. Examples are the acids, such as *acidum nitricum*, *acidum hydrochloricum dilutum*. The preparations are not acids *of* nitric or diluted hydrochloric. The adjective diluted has to conform in number, gender and case with the word it modifies.

Following are a few titles which illustrate a variety of endings.

1. *Acidum sulfuricum*—sulfuric acid
2. *aethylis oxidum*—oxide of ethyl
3. *adeps lanae hydrosus*—hydrous fat of wool
4. *albumini tannas*—tannate of albumin.
5. *ammonii bromidum*—bromide of ammonium.
6. *aqua ammoniae*—water of ammonia
7. *aqua chloroformi*—water of chloroform
8. *atropinae sulfas*—sulfate of atropine
9. *coffeina cum sodii benzoate*—caffeine with sodium benzoate
10. *tinctura balsami tolutani*—tincture of tolu balsam
11. *tinctura digitalis*—tincture of digitalis
12. *veratrum viride*.

In this first lesson an attempt has been made to introduce the problems of the latinization of the titles of the Pharmacopoeia and the National Formulary. Each of the cases and the declensions will be considered in detail in the succeeding lessons. In addition the prepositions, as used in titles and in prescriptions will be studied. Conjunctions, numeral adjectives and adverbs, and verbs as they apply to prescription reading will be covered. Other subjects to be covered during the term are the Latinization of modern words, prefixes and suffixes, and the Latin of prescriptions.

One weekly session of this course will be devoted to a detailed study of the problems of the Latinization of the titles of the Pharmacopoeia and the National Formulary and to the Latin terms and abbreviations which are necessary for an understanding of prescriptions. This will include some reading of practical prescriptions, a good number of which we have on file. Much of the time of each session will be given to the pronunciation of words and titles both, as a class and as individuals.

*How Important Is Nomenclature**

"O, be some other name!

What's in a name?

That which we call a rose,

By some other name would smell as sweet"

We have all heard modifications of this quotation all of our lives but it offers little comfort to those of us who have to struggle with the problems of nomenclature.

There is nothing unique about this problem. There are more than a hundred years of discussion of it in our pharmaceutical literature. We quote from an unnamed writer of 1842¹ as follows:

"The practice of designating substances according to their known or supposed constitution, is now generally adopted by scientific chemists, and this system possesses the advantage of presenting to the mind a more definite idea of the nature of various bodies, than could be conveyed by a arbitrary nomenclature."

There were those in that day, however, who regretted that the names of medicinal compounds should have any relation to their clinical constitution.

Jacob Bell a distinguished British pharmacist in 1842, said:

"The ambiguities which arise in chemical nomenclature from the progress of discoveries, and the change which, from the same cause, are introduced into pharmaceutical processes, must unavoidably occasion some temporary inconvenience when a new edition of the Pharmacopoeia is published."²

In speaking of pharmaceutical names, Haselden in 1859, said:

"... how much appears to depend upon a name: in giving new names or altering old ones, let that which shall convey the best accounts of the preparation, combining as far as possible simplicity and utility, be the chosen ones."³

In reviewing the U. S. Pharmacopoeia of 1860 Taylor made the statement that, "Much confusion and uncertainty have heretofore prevailed in relation to the proper classification and nomenclature of the various solutions, aqueous and alcoholic, required by the Pharmacopoeia."⁴ He went on to say the committee had transferred several *solutions* to *waters*, and *tinctures* to *spirits* all of which indicates the ever present problem of nomenclature and classification of pharmaceutical preparations.

In 1865 Hanbury, in speaking of Pharmacopoeial nomenclature, said, "... it commonly happens that upon the publication of a

*This part of the discussion was prepared with the teachers of the seminar in mind.

pharmacopoeia the first strictures that appear have reference to changes in nomenclature, which seem the inevitable concomitants of each new edition."⁵

Wilson said in 1867 that the nomenclature of the day was totally inadequate for the purposes of science and went on to say that "there was little doubt that the future historians of science would speak of the present time as the era of theoretical anarchy."⁶

Perhaps we of the present are not so bad off for according to Brough "The forthcoming Pharmacopoeia will therefore contain two sets of symbolic formulae, presenting two phases of chemical science, between which there is almost as great a difference as there is between the Ptolemaic and Copernican systems of astronomy."⁷

Lavoisier got the world out of much difficulty when in 1790 he invented a system of nomenclature which, according to Attfield, served England and America well for many decades. "The fundamental principle on which it was founded was, that the name of the salt should express its composition."⁸

In speaking of the nomenclature of the U. S. Pharmacopoeia, Hallberg⁹ in 1910 said that the present U.S.P. nomenclature is practically that of 1820, that the changes of consequence were in the chemical and botanical parts and not in the pharmaceutical portions. He maintained that a nomenclature should have the following attributes in the order named.

1. descriptiveness
2. definiteness
3. flexibility
4. brevity
5. euphony

The fears of Hallberg have been borne out for he said nearly 40 years ago now that the nomenclature of the synthetics is a serious problem. We know that too well.

As far back as 1923 rules governing nomenclature were adopted by the American Chemical Society and British Chemical Society.¹⁰ In 1934 "A Report of the Nomenclature, Spelling, and Pronunciation Committee" of the American Chemical Society published its report in the *Industrial and Engineering Chemistry*.¹¹ This four page report is comprised of almost 3 columns of dis-

cussion and explanation of the problems of pronunciation with much attention given to word endings. The remaining 5 columns consist of chemical words arranged alphabetically and marked for pronouncing. This is something that we in pharmacy are neglecting. We seem not to see the value of furnishing aids to pronunciation.

This brings us up to the present, face to face with what is termed by many, especially teachers and students, as being a problem about which there is much confusion and which calls for more cooperation and unanimity of thought if it is ever to be solved. The problem centers around the task of finding acceptable names for complex, synthetic chemical medicinals which appear annually in great numbers.

So far as the committee on nomenclature of the Pharmacopoeia and National Formulary are concerned they are not privileged to use commercial names and consequently invent new, and often uneuphonious names which too often give little hint as to the nature of the preparation.

At my request one of my associates furnished me with a short list of official titles which he believes should be given names that more nearly express the chemical constitution of the products. At least they illustrate the problem and one man's thinking about it. The official U.S.P. titles are given and the suggested titles follow them.

1. Acetophenetidin—*p*-ethoxyacetanilid
2. Amyl Nitrite—isoamyl nitrite
3. Amylene Hydrate—*tert*-amyl alcohol
4. Menadione—2-methyl-1, 4-naphthoquinone
5. Methylparaben—Methyl *p*-hydroxybenzoate
6. Sulfathalidine—phthalylsulfathiazole
7. Sulfamerazine—sulfamethyldiazine
8. Urethane (U.S.P. XIII)—ethyl carbamate (U.S.P. XII)

These are examples which present the views of but one organic chemist who finds that students are greatly confused and burdened with the problem of having to learn so many difficult names, often more than one for the same chemical compound. Students feel that where at all possible the title should reveal the chemical character or structure of the compound. This, of course, is not possible in every case. A point in case, too simple perhaps, is

that ethyl carbamate is a better technical name than urethane for the compound that these names represent.

There is need for simplifying the titles for the endless number of medicinal chemicals which appear annually and there is no justification for multiplying them. How is this to be done? It would seem to me that the educators in pharmacy and medicine, should cooperate closely with the manufacturers of these products in an effort to unify and simplify the naming of the new compounds which are to find their way into medicine. Perhaps the Food and Drug Administration should have a voice in the problem. The committees on nomenclature of the U.S. Pharmacopoeia and the National Formulary need the advice of others in formulating titles for new admissions into these texts. It would seem therefore, that a committee of pharmacists, and physicians of national scope should be set up whose duty it would be to formulate or assign names and titles to those medicinals which find their way into the trade.

In making this suggestion I am not unmindful of the fact that the Council on Pharmacy and Chemistry of the American Medical Association is guided by a very clearly defined set of "Official Rules" in giving consideration to items submitted for description in *New and Nonofficial Remedies*. In a recent communication from the Council the assistant secretary wrote as follows:

"The Council gives consideration to trademarked names for new drugs as well as to the coining of suitable generic designations that can be employed in place of the unwieldy chemical designations which characterize many of the new synthetic compounds."

Concerning protected names Rule 5 of the official Rules of the Council, page 16, states that:

"The Council therefore deems it advisable to accept several protected names for the same article, provided there are no reasons which would render this especially objectionable and harmful, and provided the common or generic name is not unduly subordinated to the protected name, in the opinion of the Council. This means that accepted drugs should always be identified by adding the generic or official name when the protected name is used, as for example, "Luminal, brand of phenobarbital," and "Benzedrine, brand of amphetamine."

Concerning pharmaceutical preparations the Council requires that "trade names be applied only to the active ingredient or in-

gredients and that a particular preparation or dosage form be designated suitably to indicate its pharmaceutic character."¹² For example if Naphrazite is protected and is sold in the form of a solution, the salt of naphrazite could not be recognized under any other trade name. In other words more than one salt from a drug is protected only in so far as the parent substance is protected. If "Artificialine lactate" can be accepted only if "Artificialine" is the unqualified name of the base.

This reference to the actions of the Council on Pharmacy and Chemistry of the American Medical Association has diverted our thinking away from the central problem but it is, at the same time, closely related.

Our discussion has drifted into the selection of appropriate and acceptable names for the new, mostly synthetic chemical preparations. This is but a portion of the problem of nomenclature. Let us not lose sight of spelling, pronunciation, and word order, and in the matter of preparations the classification of them. However, the present monograph arrangement in the Pharmacopoeia and the National Formulary de-emphasizes pharmaceutical classes.

What is there for us to do about these problems except to talk about them?

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Colloid Emulsion and Suspensions

T. HIGUCHI, PH.D.

School of Pharmacy, University of Wisconsin

At a recent Teacher's Conference held at Jacksonville considerable time was spent in debating exactly how and what part of the colloidal science should be included in the pharmaceutical curriculum. All participants were seemingly in agreement as to the importance of this field of study to pharmacy. Statements made reflected, in general, the practically unanimous desire of the group for not only inclusion of the subject matter but also its treatment in a substantial rather than superficial manner.

In contrast to this agreement in principle there appeared to be some dissension as to how this should be carried out. Some of the participants felt that only purely applied phase of the material should be taught without expending too much of the students' time on the fundamentals. Others favored modification of the pharmaceutical curriculum so that colloids, emulsions, and other applied physical chemical aspects of pharmacy could be built on fundamental, basic courses including physical chemistry.

In this paper no attempt will be made to cover the relative merits of the two viewpoints. My colleagues, Dr. Busse and Dr. Goyan, have presented in essence our feeling regarding this matter. Instead our concept of what can be done and is possible in the teaching of physical pharmacy, if our students were provided with an adequate background in the basic sciences, including physical chemistry, will be presented for your discussion. My assigned topic is Colloid Emulsion, and Suspension. However, in this discussion, I would like you to consider the subject matter as mere framework on which our ideas regarding pharmaceutical education are hung.

In the limited time available we will attempt to do three things; 1) survey briefly the essential subject matter, 2) discuss one or two topics in the outline in sufficient detail to illustrate the quantitative approach, and finally 3) examine the advantages or disadvantages of such an approach in providing the student with scientific working tools for his profession.

*Colloids, Emulsions, and Suspensions***I. Surface Properties**

- A. Types of Surfaces
- B. Surface Energies
- C. Surface Properties of Solutions

II. Colloidal State

- A. Definitions and Classifications
 - 1. Phase types
 - 2. Colloidal against crystalloidal
 - 3. Inorganic and organic
 - 4. Lyophilic and lyophobic
- B. Properties Associated with the Colloidal State
- C. Stabilization of Colloids
 - 1. Electric charge
 - 2. Protective colloid
 - 3. Particle size

III. Emulsions

- A. Types
 - 1. Oil in water
 - 2. Water in oil
- B. Factors Affecting Emulsion Stability
- C. Role of Emulsifiers
- D. Viscosity of Emulsions
- E. Emulsions of Solutions

We have here a very simple outline of the subject matter to be covered. It is evident on perusal that the student is expected to have a prior solid grounding in the fundamental properties of matter and energy. Such terms as viscosity, osmotic pressure, vapor pressure, free energy, etc., should, by now, be familiar terms to him.

Since surface properties are important factors in determining wettability, acquisition of electrical charges, adsorption of surface active agents, etc., of colloids and emulsions, these are taken up first in the outline. Under types of surface we need discuss only four types of interfaces, viz., solid-gas, solid-liquid, liquid-liquid, and liquid-gas. The energies inherent in the formation of these surfaces should be taken up next with discussion of the origin of surface tension and comparison of free surface energy with total surface energy preferably in relation to intermolecular forces.

After discussion of surface phenomena and properties, colloidal state, itself, is taken up. Terms and classifications are first explained or defined. It may be appropriate at this point to mention that no definition can sharply differentiate between true solution and a colloidal solution.

Some people, including good physical chemists, state that colloidal solutions exhibit tyndall effect or turbidity whereas true solutions do not. Actually all liquids and solutions ranging from protein solutions to solutions of NaCl scatter light to varying degrees. The intrinsic scattering power or turbidity of a solution is approximately proportional to the molecular weight of the solute. Bigger the molecule greater the scattering power. Since colloidal particles usually have high molecular weight, they are intrinsically better light scatterers. Any solute, however, will produce some scattering. Turbidity or light scattering is only one of the many colligative properties of solutions. Osmotic pressure, depression of freezing point, lowering of vapor pressure, light scattering, etc., are all quantities which can be related thermodynamically, colloidal solution⁴ following the same laws as the so-called true solutions.

The division of colloid science into organic and inorganic colloids is used by some teachers. This may have certain practical value but is of little theoretical significance. More fundamental division, however, is into lyophilic and lyophobic types. Here carbohydrate and proteinaceous colloids can be discussed and compared to the lyophobic types such as emulsions, metal sols, sulfur sols, etc.

Properties associated with the colloidal state deserve critical discussion. Osmotic, kinetic, and electrokinetic properties of colloid should be taken up under this heading. In general an attempt should be made in this section as in the entire course to develop quantitative concepts of these phenomena.

Factors governing the stabilization of colloids are, of course, of utmost importance to the pharmacist. These include electrical charge, the presence or absence of a protective agent, particle size, etc.

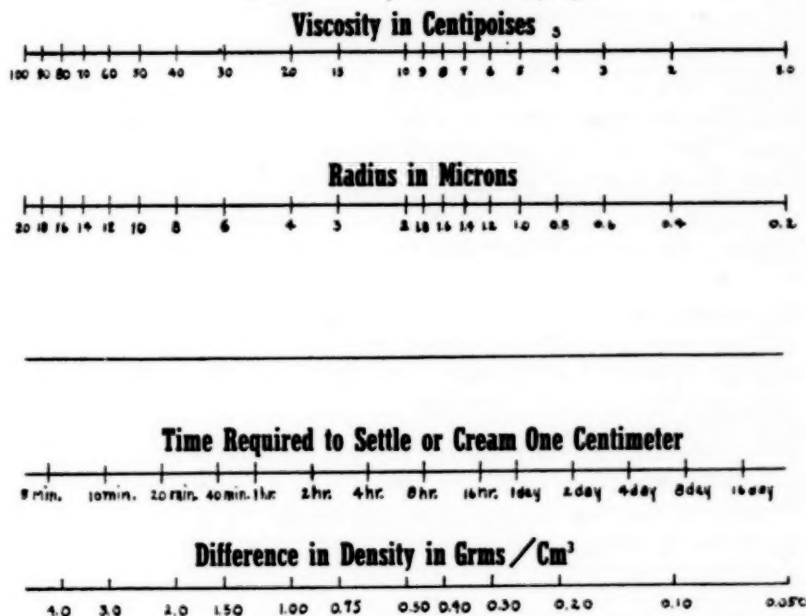
Emulsions are similar in their properties and behavior to suspensions and colloids but are usually treated separately because of their pharmaceutical importance. Types of emulsions are cov-

ered. Next the factors governing their stability are taken up. The part emulsifier or surface active agent plays in the emulsification process and stabilization is then discussed. Viscosities of emulsions, although of great interest, is usually ignored. It however, deserves some attention. Pharmaceutical emulsions are usually emulsions of solutions. The part emulsification plays in modifying solution equilibrium is of pharmaceutical interest.

This outline covers the bare fundamental of colloids, emulsions and suspensions. Addition of such material as separate treatments of biocolloid, special pharmaceutical preparations falling into this classification, etc., would depend on the curriculum time available and the inclination of the instructor.

Let us now take up in detail certain sections of the outline and see how, if possible, we can introduce more quantitative concepts into our teaching. For this experiment I have chosen several topics under section III on emulsion.

Illustration of the Nomograph



NOMOGRAPH OF STOKES' LAW

As our first example let us take a case of emulsion instability. One type is manifested grossly by the creaming process. The rate of creaming (or sedimentation if we are considering small solid spherical particles) is governed by Stokes Law. By equating the viscous drag, which can be derived from hydrodynamical consideration, to the bouyant force we obtain the common form of the Stoke's equation. Although nearly all pharmacy students see this equation it means little to them since they are rarely asked to apply it. In order to encourage greater use of this very important and useful relationship, a nomograph such as shown may be of some value.

I would like to just mention emulsifier very briefly. A full and complete discussion of emulsifier and emulsifying aid is out of place in an undergraduate course because of the time element involved. It is essential, however, to give the students some ideas regarding the physical and chemical behavior of this important class of material. For example, the tendency of surface active agents to be absorbed at interfaces, also to form micelles above certain critical concentration, these are phenomena which should be covered.

The last topic which I want to mention, is the equilibrium state which may be set up between the emulsion phases. Students rarely consider the possible effect the emulsification process may have on a solution equilibrium which may exist in one of the phases. For example ordinary soap solution has a pH of around 9.5; on addition of an oil phase to the system, be it benzene, olive oil, mineral oil, or carbon tetrachloride the pH rises to around 10.5, resulting roughly in tenfold increase in the alkalinity of the system. The change can be explained on the basis of increased hydrolysis of the soap produced⁶ by extraction of hydrolyzed fatty acid from the water phase.

Let us turn to the third objective of this discussion, viz. a discussion of the advantages or disadvantages of a physical pharmacy course constructed along this line. If pharmacy is a scientific profession, a premise I think on which we all agree, it must be on quantitative basis. To be on quantitative basis we must be able to solve numerical problems dealing with pharmaceutical technology. Physical pharmacy makes this possible.

What can be done and is possible in the teaching of physical pharmacy, if our students were provided with an adequate background in physical pharmacy is further illustrated by the type of problems attached to this report. A quantitative knowledge of stability of pharmaceutical emulsions, of partition of therapeutic agents between two phases, of rate of drug diffusion should be among the working tools of a professional pharmacist. These are unquestionably pharmaceutical problems. If pharmicists of tomorrow are not trained in this area, pharmacy as a science will cease to exist.

Chief criticisms of this course have come from those who fear that our students are incapable of absorbing the "highly mathematical" content of the course. Any student who can finish a basically sound course in physical chemistry should experience no trouble with physical pharmacy since the latter is the applied aspects of the former.

Representative Problems

1. Assuming that blood plasma consists of approximately 0.16 N NaCl and 4% serum albumin with an equivalent weight of 5000, calculate the concentration of NaCl which will be in equilibrium with blood plasma across a membrane permeable only to water and NaCl.
2. How much soap would be required to emulsify 100 cc. of oil in 1000 cc. of water so that the surface mean average diameter of the oil droplets is one micron and interfacial tension at a minimum.
3. What would be the average particle size if only one half of above quantity of soap was used?
4. What would the approximate viscosity be if 2% solution of 100 cps methyl cellulose was used instead of water?
5. Calculate the time required for the emulsion droplets in problems 2, 3, and 4 to cream one centimeter assuming oil density of 0.88.
6. If one cc. of propylene glycol was dispersed as one micron droplets throughout a room 2x4x8 meters in size, how many droplets would be present per cc.? What would the total surface area presented by the glycol be?
7. Knowing the dissociation constant and the partition coefficient of benzoic acid between benzene and water, calculate the effect of emulsification on the pH of 100 ccs. of a solution tenth molar with respect to sodium benzoate when added to 100 cc. of benzene.
8. At what pH would the acid be equally distributed between the two phases?

9. What would you expect the approximate ratio of the diffusion constants of glucose and sucrose to be? A drug 10 A in diameter and one 20 A in diameter?
10. Solubility of olive oil in soap solution increases sharply above concentration of 0.04%. Why?
11. Assuming no convection current, draw a plot showing the equilibrium distribution of sulfur in form of one micron particles in a homo-dispersed sulfur sol containing 1% sulfur.
12. Calculate the density of a suspension of particles given the following information:
Volume equal 500 cc.; total weight of particles equal to 50 gm.; density of particles 2.22.
Calculate the viscosity using Einstein's equation.

Incompatibilities*

DALE E. WURSTER

University of Wisconsin School of Pharmacy

The Pharmacy Teachers' Seminar was conceived for the purpose of discussing with educators teaching methods in pharmacy. In this particular period of pharmaceutical education, however, it appears that the selection of subject matter requires as much attention as the teaching methods. An instructor may employ excellent teaching methods, but if the course material is not adequate, the student will not benefit greatly. Therefore, in this paper, an attempt is made to treat both teaching methods and the subject material.

Much of the theoretical background material required for the study of prescription incompatibilities may be acquired from such courses as qualitative analysis, quantitative analysis, organic chemistry, physical chemistry, other pharmacy courses, and pharmacology. Some educators are of the opinion that with this background it is not necessary to devote additional time to the study of incompatibilities as a separate section of the dispensing course. Other educators in the field, however, feel that the subject of incompatibilities should be treated as a distinct phase rather than as

*Presented at the Pharmacy Teachers' Seminar held at the University of Wisconsin School of Pharmacy June 27-July 9, 1949.

isolated information about a drug when that particular drug is considered in dispensing. To this latter group it is apparent that the student must receive intensive training in this special phase of dispensing in order to make maximum use of his scientific background in the solution of prescription problems.

Upon occasion it has been said that the incompatible prescription is an exception and that the pharmacist need not know a great deal about incompatibilities since the proprietaries marketed by the pharmaceutical companies are usually prescribed *per se*.

All of us may agree that incompatibilities are the exception rather than the rule, but like the physician it is when the pharmacist encounters the unusual that his proficiency is manifested. The average physician has little difficulty in recognizing the common diseases of man, but it is the rare disease that challenges and tests his knowledge of medical science.

When new drugs appear on the market and the physician is detailed by the medical service representatives, the physician may prescribe a certain drug as such for a period of time. Oftentimes he may observe that desirable responses are not obtained in all cases with that particular drug and an attempt may then be made to modify its activity by prescribing it in combination with another drug. This leads to possible incompatibilities and, thus, the number of potential prescription problems may actually be increased through the advent of new drugs and proprietaries rather than decreased.

The pharmacist must be a drug specialist who is capable of recognizing and correcting incompatible prescriptions. He should serve as a consultant to the physician who requests information pertaining to the action and manner of prescribing a drug. Certainly, great emphasis should be placed on such an important phase of pharmaceutical dispensing, and since it is the ability to solve prescription problems by which the capabilities of the pharmacist are measured, a separate treatment of the subject seems necessary.

Object

The primary objective of the study of incompatibilities is to train the student to recognize the presence of incompatibilities in prescriptions. The student should be able to predict an incompatibility before attempting to compound the prescription. In the

event of an obscure incompatibility the student should be able to analyze the result and arrive at the proper corrective procedure when an undesirable and unforeseen reaction has taken place.

Adequate background should be developed so that the student can approach those problems arising with the advent of new drugs as well as those used in present-day medicine.

In the past, prescription incompatibilities were often taught by supplying the student with a list of incompatibilities of a certain compound. Long lists of prescriptions containing incompatibilities were also given to the student without placing too much emphasis on the fundamental scientific principles. As a result of this method of presentation, incompatibilities were usually memorized as series of specific examples with little or no consideration for the mechanism whereby the incompatibility was brought about. Since prescription incompatibilities are constantly changing, it seems inadvisable to attempt to teach them with stereotyped examples.

Naturally, there may be many good approaches to the study of prescription incompatibilities. The approach presented here which utilizes the electronic theory and places great emphasis on the theory of solubility is only one possible approach. Other approaches may also be logical and effective.

As previously mentioned, the prerequisites for the study of incompatibilities according to the proposed manner of teaching the subject are a fundamental knowledge of the electronic and solubility theories. The student may acquire this background in other courses or it may be necessary to expose him to it before embarking upon the main subject of incompatibilities.

Electronic Theory

Inasmuch as the electronic theory has acquired such prominence in the explanation of chemical phenomena, it is probable that most pharmacy students will already have been exposed to the basic principles in their chemistry courses, especially organic and physical chemistry. It seems logical that this important concept should be utilized to explain similar phenomena which occur in pharmaceutical dispensing and other pharmacy courses just as it is utilized in the teaching of chemistry. It is to be emphasized

that this material is a valuable teaching tool for the explanation of *compatibility* as well as incompatibility.

The advantage of the use of the electronic theory as a method of teaching prescription incompatibilities lies in the fact that it is directly applicable to the prescription and the student is thus able to explain what takes place in compounding procedures.

Solubility

A basic knowledge of the electronic theory is necessary to understand the theory of solubility. It is commonly stated that a knowledge of solubilities is the key to prescription incompatibilities; however, solubilities should not be memorized. When the student knows the theory of solubility it is easy for him to understand the problems of immiscibility, insolubility, cementation, and decreased solubility due to the addition of another solvent or substance which are commonly referred to as pharmaceutical or physical incompatibilities. It makes little difference whether it is a problem involving a substance which is initially insoluble in the medium or whether an insoluble substance is formed due to a chemical reaction. The student must know the reason for the insolubility and the reason for its solubility in another solvent if he is to be able to correct the prescription. It is not sufficient for the student to know simply that water and alcohol are miscible. He should know that they are miscible due to a dipole-dipole interaction and the reason for the presence of a dipole in the two compounds. In order to understand the reason for the dipole, the student must go back to his basic knowledge of electronics. Certainly, by the same token the student should know why mineral oil and olive oil are not miscible with water, and that if a homogeneous preparation is desired, the process of emulsification must be employed.

Incompatibilities—General

This point marks the beginning of the study of incompatibilities. It is necessary for the student to acquire an appreciation for dispensing problems. Thus he should be acquainted with the various types of incompatibilities such as therapeutic or physiological, pharmaceutical or physical, and chemical, and the manner in which they manifest themselves.

Incompatibilities of Inorganic Compounds

In teaching the incompatibilities of inorganic compounds it seems advisable to study only the cation component of inorganic compounds. The metals may be taken up in the same groups as they appear in the periodic table. This order is the same as in the inorganic chemistry course and, therefore, already familiar to the student.

The incompatibilities of each group of metals should be preceded by a discussion of their solubility characteristics and chemical reactivity with particular attention paid to the electronic aspects.

It does not seem necessary to take up the anions as separate groups since they will repeatedly be referred to in the discussion of the cations. A separate discussion of the anions of inorganic compounds thus becomes time consuming and repetitious.

Although of equal importance to those of organic compounds, the incompatibilities of inorganic compounds are fewer in number since inorganic compounds are prescribed less frequently.

Incompatibilities of Organic Compounds

In the study of the incompatibilities of organic compounds it is convenient to use a similar classification to that used in organic chemistry. Sub classes may also be added to fit the subject matter. This classification serves a dual purpose in that (1) it is the same as that used in organic chemistry and thus is not new to the student, and (2) new drugs may be easily incorporated simply by placing them under their respective chemical class.

Just as is done with inorganic compounds each class of organic compounds should be introduced with a discussion of its solubility characteristics and its chemical properties. Electronics should be used to the fullest extent in explaining these properties. In this manner the student is shown how to determine the incompatibilities of other members of a particular organic class rather than memorizing the incompatibilities of each drug.

Laboratory

The prescriptions which are utilized in the laboratory should be representative of the type incompatibilities currently encountered

by the pharmacist. It has a desirable psychological effect upon the student if he knows that the problems which he is asked to solve in the laboratory are actual incompatibilities which physicians have written. The prescriptions used in the laboratory may, therefore, be obtained from such sources as 1. The Prescription Service section of the Journal of the American Pharmaceutical Association (Pract. Ed.) 2. Drug store prescription files, or 3. The Professional Pharmacy Forum of the American Druggist, etc.

Manner of Testing

Testing of the students' knowledge of the subject should be accomplished by having him analyze prescriptions which he has not previously seen but only after he has already applied the scientific principles in the laboratory.

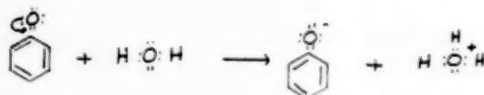
It is not necessary to present prescriptions in their entirety in the lecture. Incompatibilities between two or more substances may be discussed but it is only in the laboratory and examination that the student is given a prescription. He must then arrive at his conclusions concerning the incompatibility and the manner of correcting it purely on the basis of his scientific background.

Illustrations

A few illustrations of the use of the electronic theory are given in the following discussion. It is emphasized, however, that the material presented is not limited to the specific examples used and that other examples could have been selected and their incompatibilities just as readily explained irrespective of the class of chemical compounds to which they belong. Naturally time and space do not permit a detailed discussion of the electronic aspects and, therefore, only some gross considerations are treated in the following examples.

1. Phenols—Chemically phenols fall in the same class as alcohols, but in contrast to the alcohols the phenols are characterized as being acidic substances. The cause of acidity may be explained on the basis of the presence of the acidic (electrophilic) phenyl group. The unsaturated, electron-deficient phenyl group tends to withdraw electrons from the oxygen. The electron pair of the oxygen-hydrogen bond is, therefore, held more closely to the oxy-

gen; the proton is more loosely held, and there is a tendency to ionize in aqueous solution by donating a proton to the more basic compound, water.

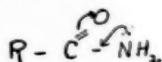


Salt formation such as soluble phenates of the alkali metals and incompatibilities involving the formation of insoluble phenates of heavy metals are thus easily explained to the student.

Even though phenols are acidic substances, they are only weakly acidic and do not dissociate sufficiently to be soluble in water through an acid-base reaction but are solubilized due to a permanent dipole-permanent dipole interaction. The increased solubility of resorcinol over phenol may be shown on the basis of the additional -OH group in resorcinol which tends to increase the dipole-dipole interaction. The introduction of non-polar substituents on the aromatic nucleus such as occur in hexylresorcinol and its effect in decreasing the polarity and water solubility may then be considered.

A more complete treatment of this class of chemical compounds would, of course, include a discussion of the principle resonance forms, substitution in the ortho and para positions with electrophilic reagents, and oxidation and reduction reactions.

2. Barbiturates—In the case of the barbiturates most incompatibilities are the result of acid-base reactions. Here it is convenient to show the student why such nitrogen-containing compounds as the barbiturates are acidic. This may be accomplished by first using more simple compounds, e.g., the amides. Acidic groups when substituted for a hydrogen of ammonia cause a decrease in basicity. In the case of the amides the shift of a pair of electrons from the double bond between the carbon and oxygen tends to cause an electron deficiency on the carbon atom, which in turn

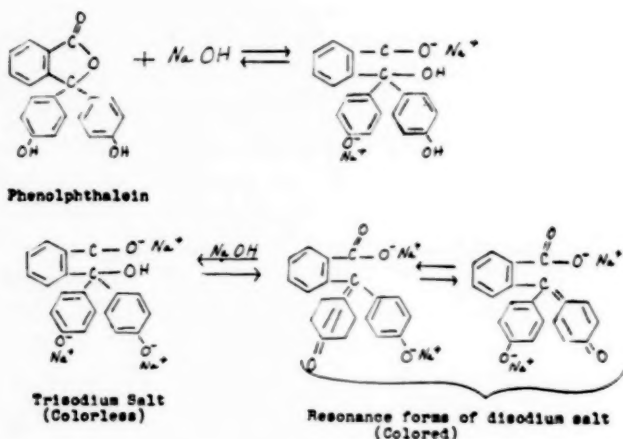


is satisfied by a shift of the unshared electron pair of the nitrogen thus causing an increase in the covalency between the nitrogen and

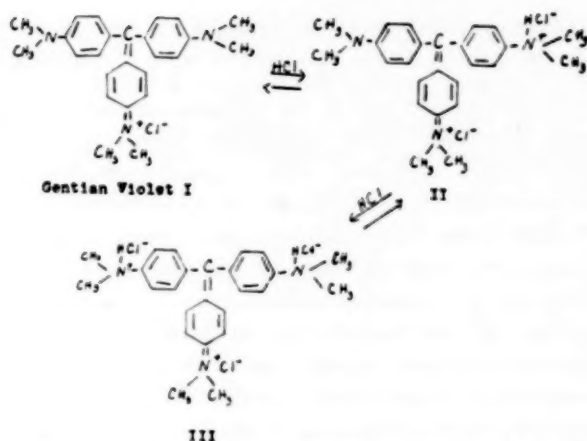
derstand this incompatibility the student must possess some knowledge of the theory of dyes and the contribution of resonance to color production.

The student is aware that basic nitrogen-containing compounds readily form ionizable water-soluble salts with acids. He will thus occasionally experience some difficulty in predicting an incompatibility of this nature unless he possesses a basic background in electronics and understands resonance.

A simple approach to the problem is to select a compound with which the student is familiar. This may be such a common indicator as phenolphthalein. Assuming that the student understands resonance, it becomes easy to show him that the disodium salt is colored due to the possibility of resonance which exists and that the trisodium salt is colorless since resonance is decreased.



A similar situation may now be shown to exist with other dyes such as gentian violet, malachite green, and methylene blue.



The color change noted here in structure III is also due to the decreased resonance brought about by tying up all the nitrogens in salt formation.

Since pharmacy today is a highly applied science, emphasis should be given to the application of scientific principles rather than to the practice of pharmacy as an art. A great many examples could be given here but the following will serve to illustrate this point.

1. The use of alcohol to solubilize water-insoluble substances—It is obvious that alcohol will not solubilize all the substances encountered in prescriptions. Yet, unless the student is shown how alcohol functions as a solvent, he will be at a loss as to when to use this important solvent.

2. The use of alkali citrates to solubilize water-insoluble aromatic carboxylic acids—in order to use this substance wisely the student must realize that the ionizable water-soluble salts of these aromatic carboxylic acids are formed and that these salts are soluble due to a permanent dipole-ion interaction; the free citric acid formed in the reaction being water-soluble due to a permanent dipole-permanent dipole interaction.

3. The use of citrates to prevent the precipitation of iron salts form aqueous solution—the citrates are often listed as agents to be used to prevent the precipitation of insoluble iron salts without discussing the mechanism whereby the incompatibility is cor-

rected. The judicious use of these agents is dependent upon the knowledge of their function as sequestering or complexing agents.

4. The use of alcohol in the extemporaneous preparation of a tragacanth mucilage—every pharmacist knows that if powdered tragacanth is first triturated with a small quantity of alcohol, hydration occurs much more rapidly than if water alone is used. It should, of course, be pointed out that while tragacanth is insoluble in alcohol and will be precipitated from aqueous solutions if the alcohol concentration is too high, only very small amounts of alcohol are used in this procedure. When alcohol and tragacanth are triturated together each small particle of gum becomes surrounded with alcohol. Upon the subsequent addition of water, the water and alcohol associate through hydrogen bonding and the water is thus drawn through the mass so that each small particle of gum is now surrounded by water. Hydration, therefore, takes place more rapidly than when water alone is used. Hydration of the gum is brought about through association with water. This procedure may also be applied to other gums, and other water-soluble hydroxy compounds such as glycerin may be used in place of alcohol.

Once the student possesses an adequate background these procedures are no longer isolated cases to be memorized but are methods applicable to many situations. If the student only knows that he should use a certain substance or procedure in a specific case the practice may be truly classified as an art or skill. However, when he knows the reason underlying such procedures the execution becomes the application of scientific principles.

It has been the writer's observation that most students learn with relative ease the various technics required for prescription compounding once they learn the reason for employing such technics. Thus, the order of mixing which may be troublesome to some students is no longer a problem when the student knows the chemical and physical properties of the compounds he is using.

In view of the rapidly advancing boundaries of scientific knowledge the teacher of pharmacy must utilize all pertinent scientific information at his disposal in the teaching of pharmacy or he is not doing justice to either the student or the profession.

Contributions of the Teacher of Pharmacognosy to the Course in Dispensing*

MITCHELL J. STOKLOSA

Massachusetts College of Pharmacy, Department of Pharmacy

One of the objectives of the course in Dispensing is the application of the knowledge acquired by the student in all the other courses that comprise the pharmaceutical curriculum. If this knowledge has a practical meaning, as it should have in order that the objective may be realized, the student will be able to apply it more intelligently to situations that he might reasonably be expected to encounter in Dispensing and, later, in actual practice.

Realizing the necessity for greater emphasis of the practical viewpoint with respect to the presentation of teaching material, the teacher of pharmacognosy, like the teachers of all the other courses of instruction, can contribute much to Dispensing by correlating the subject matter, whenever it is possible to do so, in such a manner that the fundamental knowledge gained by the student will be more meaningful to him in the compounding and dispensing of prescriptions.

In making his contributions to Dispensing, the teacher of pharmacognosy must be fully cognizant of the fact that, in this course, the student is expected to know something more than memorized facts concerning sources, descriptions, and characteristics of medicinals from natural and allied sources. Of greater significance to the teacher of dispensing and, therefore, of more value and interest to the student, are the important dispensing points involved in the compounding of prescriptions that contain preparations of plant drugs or their constituents.

The presentation of such information in the Department of Pharmacognosy presupposes, of course, the cooperation and help of members of the Pharmacy Staff. Obviously, they are the ones who should suggest to the teacher of pharmacognosy the significant dispensing data as they apply to plant medicinals. Further, it presupposes the formulation of a properly correlated plan designed to include a discussion of these dispensing points as an integral part of the discussion of the plant drugs to which they relate.

*Presented at the Plant Science Seminar, 1950 meeting, Boston, Massachusetts.

In an attempt to organize the subject material for such a presentation, members of the Departments of Pharmacognosy and Pharmacy at the College held a series of conferences. At these meetings, the drugs that are studied in pharmacognosy were reviewed and dispensing data with respect to selected prescriptions involving some of these drugs were suggested by members of the Department of Pharmacy as worthy of emphasis.

To illustrate the type of information that was suggested as a supplement to the factual material usually presented in pharmacognosy courses, an abbreviated list of drugs together with a series of typical prescriptions and comments thereon, is presented as a part of this paper. In each instance, the compounding of the prescription involves one or more dispensing points that might well be emphasized by the teacher of pharmacognosy at the time when the plant drug in question is studied.

List of Drugs

- | | | |
|-----------------|--------------------|------------------|
| 1. Aspidium | 5. Comptonia | 9. Coca |
| 2. Ephedra | 6. Rhubarb | 10. Myrrh |
| 3. Sarsaparilla | 7. Cinnamon | 11. Benzoin |
| 4. Vanilla | 8. Peruvian Balsam | 12. Gutta Percha |

Typical Prescriptions

- | | | | |
|----------------------------|-------|-------------------------|-------|
| 1. R Oleoresin Aspidium | 4.0 | 7. R Menthol | 0.2 |
| Vanilla Tincture | 2.0 | Cinnamon Oil | 0.05 |
| Syrup q.s. ad | 30.0 | Liq. Petrolatum ad | 30.0 |
| Sig. Take at one dose. | | Sig. Nose drops. | |
| 2. R Ephedrine | 1% | 8. R Calamine | 2.0 |
| Normal Saline ad | 30.0 | Peruvian Balsam | 4.0 |
| Sig. Nasal Spray. | | Ung. Zinci Ox. ad | 30.0 |
| 3. R Sodium Nitrite | 2.0 | Sig. Apply. | |
| Syr. Sarsapar. Co. ad | 120.0 | 9. R Cocaine | 0.3 |
| Sig. 4 cc. t.i.d. | | Menthol | |
| 4. R Vanillin | 0.06 | Camphor aa | 0.1 |
| Ol. Eucalyptus | | Liq. Petrolatum ad | 15.0 |
| Liq. Petrolatum ad | 30.0 | Sig. For the nose. | |
| Sig. Use as nose drops. | | 10. R Myrrh Wash | 240.0 |
| 5. R Decoction Sweet Fern | 240.0 | 1-16 | |
| (fresh) | | Sig. Apply as directed. | |
| Sig. Apply every two hours | | 11. R Benzoin Tincture | 2.0 |
| for itching. | | Glycerin | 30.0 |
| 6. R Sodium Bicarb. | | Rose Water ad | 120.0 |
| Sodium Bromide aa | 15.0 | Sig. For the hands. | |
| Aq. Chlorof. | 30.0 | 12. R Traumaticin | 50.0 |
| Inf. Rhei. ad | 180.0 | Sig. For office use. | |
| Sig. 4 cc. ex aq. | | | |

Suggested Dispensing Points

1. *Aspidium Oleoresin* must be thoroughly mixed before it is used in the compounding of the prescription.
Aspidium Oleoresin, when prescribed in this manner, must be emulsified. It is treated as a volatile oil, and the emulsion is prepared by the Continental Method.
2. The solubility of *ephedrine* is a significant physical property of the alkaloid. *Ephedrine*, while soluble in liquid petrolatum and in vegetable oils, differs from most alkaloids in being soluble in water.
3. Compound *Sarsaparilla Syrup* has a slight acid reaction. When used as a vehicle for sodium nitrite, it causes the formation of nitrous acid and a slow liberation of oxides of nitrogen. The syrup should be neutralized with sodium bicarbonate before it is used as a vehicle in the prescription.
4. In the preparation of solutions of *vanillin* in liquid petrolatum, a small amount of a vegetable oil should be used as an intermediate solvent. Without it, the solution will be turbid.
5. *Comptonia* or Sweet Fern is prescribed by some dermatologists in the form of a decoction for use in certain skin conditions. The decoction must be freshly prepared according to the general formula.
6. *Rhubarb* contains rheotannic acid. When infusion of *rhubarb* is prescribed with sodium bicarbonate, a very slow evolution of carbon dioxide occurs. The customer should be advised not to stopper the container tightly.
7. *Cassia Oil*, **not** *Ceylon Cinnamon Oil*, should be dispensed on prescriptions calling for *Cinnamon Oil*.
It should be emphasized that *Cassia Oil* is the official *Cinnamon Oil*.
The differences between *Cassia Oil* and *Ceylon Cinnamon Oil* with respect to cost and flavor should be reviewed.
If the sample of *Cassia Oil* used is not completely soluble in liquid petrolatum, a small amount of a vegetable oil should be used as an intermediate solvent.
8. *Peruvian Balsam* has a tendency to separate in a granular form when mixed with zinc oxide ointment. It should be mixed with either castor oil or solid petroxolin prior to incorporation with the base in order to overcome the difficulty.
9. *Cocaine* is not soluble in liquid petrolatum in concentrations above 1.25%. Mineral oil solutions containing higher concentrations of cocaine may be prepared, however, by using a vegetable oil as an intermediate solvent.
10. *Myrrh Wash* is prepared by diluting *Myrrh Tincture* with water according to the desired concentration.

11. A tincture prepared from Sumatra Benzoin will produce a better suspension in water than a tincture made with the Siam variety.
12. A solution of gutta percha, under the name of Traumaticin, is requested by some dental practitioners for office use. A 5% solution of gutta percha in chloroform is usually dispensed.

The dispensing points outlined above represent a part of a closely correlated plan that was formulated at the College for the purpose of supplementing the factual information presented in the pharmacognosy course. The organization of the subject material under such a plan and the subsequent presentation of it from a practical viewpoint offer to the teacher of pharmacognosy a unique method of approach in an attempt to make a realistic contribution to the course in Dispensing.

The Development of a Program of Student Research Projects at the Brooklyn College of Pharmacy

ISIDORE GREENBERG

Brooklyn College of Pharmacy

The Department of Pharmacy at the Brooklyn College of Pharmacy requires all senior students to write a term paper on a medical or pharmaceutical subject. Accordingly, students select a topic, have it approved by their professor, proceed to do their research and write their papers.

During my first academic year at the Brooklyn College of Pharmacy, 1948-1949, one of the senior students was, more or less independently, engaged, in lieu of a term paper, in photographing pharmaceutical apparatus and equipment on 35 mm Kodachrome film, to be made into 2" x 2" slides subsequently, for use in lectures as a visual aid.

Having been an amateur photographer for over fifteen years, this project interested me greatly. When commenting about it to

the chairman of the department, I was told that he had been interested in such projects for a long time, not only in making slides but also in the production of motion picture films of basic pharmaceutical processes. I volunteered to direct students working on such projects, to which the chairman gave his consent.

During the year 1949-1950 two senior students under my direction experimented with 8 mm film in making a movie of the technique of filling a collapsible tube. Upon showing the results of this experimentation to the chairman and the dean there was an expression of satisfaction with the results. The outcome of this was that I was encouraged to continue with the project and funds were made available for the purchase of additional equipment and supplies. Accordingly, we proceeded to refilm the process on 16 mm Kodachrome film, which subsequently turned out to be a satisfactory product. This film has already been shown several times to both junior and senior students, and the subsequent improvement in laboratory technique has certainly justified the effort.

During the same academic year another senior student asked for permission to carry out an experiment with emulsions and submit the report of the experiment for his term paper. Permission was granted and, because he wanted to include photomicrographs in his report, he was referred to me. I also volunteered to supervise his experimental work. The experiment turned out to be fairly successful, and the report, which was supplemented with photomicrographs, was accepted.

The success of the above two projects, the film and the experiment, encouraged me to suggest to the chairman that an effort should be made to expand the program of student projects, entirely on a voluntary basis. He agreed and the program came into being.

Toward the end of the year 1949-1950 and in the beginning of the year 1950-1951 announcements were made that all students interested in carrying out projects in lieu of the usual type of term paper should see me. The turnout was more than had been anticipated. Some 30 students reported, of which 25 subsequently carried through projects. After a general discussion of the objectives, topics were either selected or suggested by the students.

The distribution of projects was as follows:

Project	No. of Students
Motion Picture—Hand and Machine Made Suppositories.....	2
Motion Picture—Preparation of Pills.....	2
35 mm Kodachrome Stills of Apparatus.....	2
Prescription Surveys for the Year 1949.....	5
Comparison between the Cooper Mortar with the Traditional Wedgewood Mortar	5
Methods of Incorporating Coal Tar and Coal Tar Products into Ointments, Lotions, etc.....	1
The Effects of Various Mechanical Treatments on Emulsions....	1
The Influence of Tween 80 on the Extraction of Belladonna Leaf	1
The Use of Surface Active Agents in the Manufacture of Official Preparations	2
Abbott Prescription Survey.....	3
A Determination of the Optimum Amount of Bentonite to be Used as a Suspensoid in Prescription Compounding.....	1
Total.....	25

Students who elected to do experimental projects were assigned special lockers and apparatus, and were given permission to use the laboratories at their convenience. In the case of the motion picture films, instructors generously gave of their time to act as demonstrators. In supervising the students, I made checks on their progress once each month, and was, of course, available for consultation and advice at any time. Towards the end of the year a session was held with all students, at which time standard methods of report writing were discussed and outlined. A schedule of appointments was also arranged for all those needing photographic work to supplement their reports.

It would be superfluous to expand on the educational and experimental values to the students in conducting these projects, since some of them have been implied above and are apparent to the experienced teacher. Suffice it to say that all students were enthusiastic about their projects and gratified with the results obtained. It is hoped that some of the papers might be published. Preparations have already been begun for the following year.

In the matter of the projects resulting in visual aid materials a field is opened in pharmaceutical education. The tremendous value of visual aid materials was amply demonstrated during the last war. Its use in colleges of pharmacy has been limited chiefly to general subjects because of their availability by supply companies. But in the specialized pharmaceutical subjects they have been little used. It seems to me that they can be very effectively used, and by means of the projects mentioned above a library of visual aid materials can be built up at relatively little cost and in accordance with the needs of a college of pharmacy.

The twenty-eighth annual **Plant Science Seminar** will be held at Buffalo, N. Y., August 22-25. Several sessions have been planned for the presentation of papers, for field trips to regions of botanical interest and a tour of the University of Buffalo Campus. As customary, the watermelon party and annual banquet will highlight the social aspect of the program.

NEW IN THE FAMILY

Dawn Marie Christensen.—Born June 9, 1951, daughter of Prof. and Mrs. Edward Christensen, University of Colorado.

Arthur Maynard Zupko.—Born January 1, 1951, son of Dr. and Mrs. Arthur G. Zupko, St. Louis College of Pharmacy.

Karen Marie Schleif.—Born October 24, 1950, daughter of Dr. and Mrs. Robert Schleif, St. Louis College of Pharmacy.

Loretta Gale Prokop.—Born October 1, 1950, daughter of Mr. and Mrs. Leon D. Prokop, St. Louis College of Pharmacy.

MARRIAGES

Mr. Frank W. Martin, instructor in pharmacognosy, St. Louis College of Pharmacy, and Miss Patricia Veryl Rigley of Webster Grove, Missouri on February 21, 1951, at Kirkwood Presbyterian Church.

Mr. William F. Hill, assistant treasurer St. Louis College of Pharmacy, and Miss Bette Jane Maness of St. Louis, on July 7, 1951, at the church of St. Anthony of Padua.

The Editor's Page

The pharmaceutical world recognizes with a lot of satisfaction that in the year 1951, the Remington mantle has fallen upon the shoulders of one who so richly deserves it. The Remington medal has come home to roost, for Hugo Herman Schaefer was not only the conceiver of the idea of the award, but did the spade work and raised the funds to make the continuance of the award possible. Dr. Schaefer's unselfish services to pharmacy are too numerous to mention here and as a matter of fact they are of common knowledge, but we want to congratulate the group that makes the award on the wisdom of their choice.

This issue of *The Journal* carries "A History of the American Foundation for Pharmaceutical Education" by Ernest Little. This article was written at the earnest request of the Editor who has, for a long time, felt that the facts connected with the origin and organization of the Foundation should be made a matter of record.

The idea of a Foundation was born in Dr. Little's fertile mind. He put years of effort in doing the ground work that brought the organization of the Foundation to maturity. Since that time he has been a sort of a kingpin of the organization. Many men have unselfishly contributed to its growth and usefulness but the fact remains that Ernest Little was the individual that brought pharmaceutical industry to the support of pharmaceutical education. Characteristic of Dr. Little, one would never know from his writing that he was the master mason and that the Foundation is his own monument.

It was at the request of Dr. E. L. Newcomb that the Editor began printing abstracts from the minutes of the meetings of the American Foundation for Pharmaceutical Education, the Board of Directors, and the Board of Grants. In preparing these abstracts he has been careful to select those actions upon which the Foundation has established definite policies that all would be interested in, and has avoided subjects under consideration and also the routine

business of the Foundation. It must be an inspiration to anyone who follows the record of the Foundation to observe the interest and concern of the officers and members of the Foundation about its work and the service it can render to pharmaceutical education; also the great care which it takes in the conduct of its business, in the conservation of its funds and the awarding of its grants and fellowships. As one reads the record he is overcome by the feeling that here is a group of men who are as much concerned about the efficiency and the permanency of the Foundation as they are about their own businesses. There will be no New Deal waste of effort or money there.

Reports indicate that the acceptance of the executive directorship and secretaryship of the American Foundation for Pharmaceutical Education by Dr. W. Paul Briggs was approved not only unanimously but enthusiastically by the Board of Directors. The educational group have the same attitude toward the appointment. The Foundation is to be congratulated on this appointment and Dr. Briggs is to be congratulated on the great opportunity for service the appointment gives him.

It was the Editor's privilege to attend anniversary of the tenth birthday of the American Institute of the History of Pharmacy, at the University of Wisconsin on May 10, 1951. "The History of the Application of Science in the Health Field" was the theme of the program. For the occasion, Dr. Urdang brought to Madison a number of outstanding scholars in their respective fields. Their papers are published in the current number of *The Journal*. These papers are the evidences of the scholarly character of the program; but one needed to be present to catch and absorb the spirit of the occasion. One was reminded of what Dr. Henry E. Sigerist once said of the Institute: "It not only helps us to obtain a more complete picture of the history of civilization, but can also greatly contribute to maintaining the dignity of a profession that is threatened by various forces. In this as in other fields the historical analysis paves the way that leads into the future." One of the most impressive things the anniversary brought out was the number of young men, in the university, fired with

enthusiasm for historical study. That is due to the fact that the gentle and scholarly George Urdang is infected with something that is contagious. One cannot sit with him through a program or dinner date without wanting to go out and attempt to write history himself. Such was the contribution Hitler unwittingly made to American pharmacy when he drove George Urdang from home and native land. Well may America rejoice in the fact that for such men she has created a refuge.

If press reports are true, it would seem that the School of Pharmacy of the College of the Ozarks at Clarksville is to be transferred to the University of Arkansas on or before August 31, 1951. The reports also indicate that the University is planning for a five year program and the introduction of graduate instruction in the pharmaceutical sciences. This is certainly a commendable program and we trust the state will give the University financial support to carry it out. We wish to commend especially the College of the Ozarks, its board of trustees, its administrative and teaching staffs for the contribution made to pharmaceutical education in Arkansas. More than five years ago that institution recognized the need of introducing pharmaceutical instruction in a state where it was not available, and its own sons and daughters could not study pharmacy in other states except to a very limited extent. No one realizes the seriousness of that situation unless he has lived in a state where those conditions exist. The writer knows because that was the situation he found in the state of Arizona four years ago. The College of the Ozarks recognized the need when the state institutions did not, or for some reason felt they were not ready. So the College of the Ozarks made the effort. It did the spade work. In five years it put \$250,000 into pharmaceutical education. In addition, an untold amount of energy and work went with it. It was a fine piece of missionary work for the support of professional education in the health field. We understand the pharmaceutical equipment will be transferred to the State University, which gives it the foundational equipment upon which to build. All of which goes to show that a small church college still performs a necessary function in a great country which is saturated with educational institutions. Phar-

macy owes something to the board of trustees, its administration, and its faculties for its courage and foresight in pioneering in pharmaceutical education.

Notice of the passing of Dr. Clifford Warren Chapman, which appears in this issue, was sent the Editor by Dr. B. Olive Cole. Dr. Chapman was a Canadian by birth and training. He came to the University of Maryland in the late thirties but his personal acquaintance always remained limited because of his devotion to research. His research was extensive and well known. To his wife and children we extend our sympathy and hope for the future.

RUFUS A. LYMAN

At a recent meeting of the District of Columbia Pharmaceutical Association, Vice Admiral Joel T. Boone, Chief Medical Director of the Veterans Administration, paid tribute to the "unselfish cooperation and participation by all segments of organized pharmacy" in making possible the high calibre of medical care that now exists for veterans. He said in part:

"I have long been aware of the importance of pharmacy as a member of the medical team. During my years of service in the United States Navy, and especially during the two World Wars, I was conscious of the contributions made to the efficiency of the medical team and welfare of our fighting men by members of your profession serving as hospital corpsmen, medical technicians and pharmacy officers.

"The present status of the pharmacy program in the Veterans Administration is another indication of unselfish cooperation and participation by all segments of organized pharmacy in making possible overall medical care meeting the highest standards. Continuing efforts by the pharmaceutical industry to develop new therapeutic agents and improve those already available have made advances in medicine during the past 20 years that could not have been anticipated by the most foresighted. Manufacturers have been most cooperative in keeping our professional personnel informed of the latest advances in drug therapy."

Notes and News

Brooklyn College of Pharmacy.—Celebrating the 60th birthday of Dean Hugo H. Schaefer, his colleagues tendered him a dinner and presented suitable gifts.—The Alumni Association held a dinner commemorating the 60th anniversary of the founding of the College of Pharmacy. It was also the occasion for presenting scrolls to those who have served the college well through the years. The recipients were Edward Neimeth, Hugo Schaefer, Nicholas S. Gesoalde, and Joseph S. Goldwag.—129 students were graduated at the June Commencement. Seven of them were awarded prizes for superior scholarship.—Prof. Alexis V. Pfeiffer has been recalled to army service as a captain.—Prof. Ralph H. Cheney gave a talk recently on the botanical and commercial sources and the pharmacologic effects of American beverages before the New York Botanical Garden.—The Alpha Eta chapter of the Lambda Kappa Sigma sorority was installed at the college on June 6 by Mrs. Leary, Grand Treasurer, acting as installing officer.

Butler University.—Sixty-seven seniors were graduated in June.—Morton Embree was elected to Phi Kappa Phi because of scholastic attainments.—Earl F. Brake is working toward his master's degree at Purdue this summer.—Prof. Arthur W. Reid and Robert L. Prettyman are continuing work this summer toward the doctorate, the former at the University of Florida, the latter at the University of Colorado.—A limited number of courses in chemistry and biology are being given in the summer session.—Dr. Karl Kaufman has been elected a member of the Board of Directors of the International Association of Torch Clubs, a professional organization for men.

University of Florida.—On May 10 the following awards for scholarship were made: the Lehn and Fink Gold Medal to Joel J. Hertz, the David W. Ramsaur Medal to Hartsell Morrell, the Bristol Award to Carey Jones, and the Merck Prizes to Sarah F. Szekely and William P. Burdette. Also, the Attwood Leadership Award was given to Harry Powell.—Albert E. Brown, instructor in pharmacology, was called back into service on March 29 by the Navy as a Lieutenant. He will carry on his duties in the Medical Service Corps.

The George Washington University.—Dr. W. Paul Briggs, recently appointed Secretary and Executive Director of the American Foundation for Pharmaceutical Education, has joined the staff of seminar lecturers.—The work in Pharmaceutical Administration previously carried by Dr. Briggs, will now be done by Mr. Charles B. Hawthorne, B.S. in Pharmacy, who will receive the degree M.S. in Business Ad-

ministration in September.—Thirty-two seniors were graduated at the Spring Convocation.—Dean Charles W. Bliven has been elected second vice-president of the District of Columbia Pharmaceutical Association.—Alpha Zeta Omega initiated eight pharmacy students in April.

University of Colorado.—The annual banquet was held on June 15 with 225 in attendance. Following the banquet, prizes were awarded to outstanding students.—Dr. H. B. Van Valkenberg, who has been with the University since the establishment of the college of pharmacy and who is now retiring, was the chief speaker on the occasion and traced the growth of the college of pharmacy from its beginning in 1911 to the present time. This marks the fortieth anniversary of the school.—Dr. Harold C. Heim addressed the Weld County Pharmacal Association in June on the subject, 'Barbiturates'. He also addressed the Boulder County Medical Association on the "Enzyme Theory of Drug Action".—Mr. Fred Armstrong who is a reserve officer in the Chemical Warfare Service, has recently been on two weeks of active duty at Camp Carson.

University of Connecticut.—Fifty seniors were graduated at the June commencement. One was graduated with Highest Honors, five with High Honors, and four with Honors. Nine awards were made for excellence in scholarship.—Dr. Richard K. Thoms, chairman of the department of pharmacology at North Dakota Agricultural College, has been appointed a member of the pharmacy staff.—Miss Ruth Foden attended a meeting of the Federation of American Societies for Experimental Biology in Cleveland in April.

University of Georgia.—May 23 was the third annual Student-Faculty-Alumni Day for the school of pharmacy and several hundred alumni returned to assist in the dedication ceremonies of the new facilities. Dr. George D. Beal gave an address in recognition of the Sesquicentennial Celebration of the University. His subject was "Fifty Years of Progress in Pharmacy". Following the address, President O. C. Aderhold gave a brief address and turned the new facilities of the pharmacy building over to Dean Kenneth L. Waters, who in turn dedicated it to the health and welfare of the citizens of the State of Georgia. A few closing remarks were made by Dean Emeritus Robert C. Wilson. New features of the plant are the dispensing laboratory which will accommodate seventy-five students, a new and fully equipped pharmacological laboratory, the enlarged reading room, new offices, stock rooms and student lounge.—The annual Student-Faculty-Alumni banquet was held on the evening of the same day and the six awards for scholarship were announced on that occasion.—Dr. Frank H. Eby of Temple University installed the officers of the newly formed chapter of Kappa Psi. The chapter has fifty-eight members.—The five seniors within the University having the highest scholastic average were nominated as candidates for the honor of class valedictorian. The 1200 seniors then

voted on their choice. Michael Steblar, a pharmacy senior won by a large majority. George McClure, another pharmacy major, took second place. Both Mr. Steblar and Mr. McClure have an academic average of over 95. Mr. McClure was recently named to Who's Who Among American Universities and Colleges.

Howard College, Birmingham.—Eighty-one seniors were granted the Bachelor's degree at the June commencement and eight students were given awards for excellence of scholarship.—Mr. Joe Vance, lecturer in hospital pharmacy, gave two lectures at the Southeastern Hospital Pharmacist's Seminar held recently in New Orleans.—Several members of the staff have had papers published recently in professional journals.—Ralph Slade was honored on Scholarship and Leadership Day as the senior having the highest scholastic standing for the four years on the Howard College campus.

Idaho State College.—Alpha Upsilon chapter of Rho Chi was installed recently at the college. Dean George E. Crossen of Oregon State College acted as installing officer and presented the charter. Active in securing the chapter were Prof. Carl Riedesel, Dr. Marie Huntington and Miss Hazel Landeen. Guests at the installation dinner included President and Mrs. Carl W. McIntosh; Mr. Les Crowley, representing the Idaho board of pharmacy; and Mr. Ed Grosse, president of the State Association. Twenty-three students and 11 members of the pharmacy staff constitute the charter membership group.—Prof. Carl C. Riedesel will be on leave of absence the coming academic year in order to continue work for the doctorate in physiology at the State University of Iowa.—Larry Gale is continuing work for the master's degree in pharmacology at Washington State College the present summer.—Dr. N. Marie Huntington is spending the summer in Europe. She is visiting relatives who are engaged in U. S. government work in Frankfort, Germany and before returning in September will tour Germany, Norway, Sweden, Denmark, Switzerland and Italy by car.—The E. R. Squibb Institute for Medical Research has given the College of Pharmacy a \$5000 grant to aid the investigation of new sources of antibiotics. The project is under the direction of Prof. Ivan W. Rowland and Dr. F. G. Jarvis.—The pharmacy building is being completely redecorated in pastel shades.—Eleven new members have been initiated by Phi Delta Chi.

University of Illinois.—Four hundred and twenty-two degrees were conferred in the health sciences, 124 of them being bachelor's of pharmacy, at the June commencement of the Chicago Professional Colleges. Dr. Frank T. Maher served as master of ceremonies for the commencement program. Governor Adlai E. Stevenson gave the commencement address.—The appropriation bill for the new pharmacy building has been signed by the Governor and construction can begin as soon as the

area is cleared of the present buildings.—Seven students were awarded prizes for excellence of scholarship.—Stanley V. Susina of the pharmacy department won the Sigma Xi award on his research paper.—72 of the 124 graduates are subject to military call prior to August 1.—Twenty students and 2 faculty members have been initiated recently into Rho Chi.—Construction is underway on the new Drug and Horticultural Experiment Station at Lisle near the Morton Arboretum.—Dr. George L. Webster has been elected chairman designate of the Professional Faculty of the Chicago Professional Colleges for the year 1951-52, and Dr. Frank T. Maher has been elected as secretary of the Professional Faculty.—Construction has begun on the housing project which includes a residence hall for men and a staff apartment building. The project will total around \$4,600,000.—Applications for admission to the college of pharmacy for the next academic year exceed the total of last year by 5%. Only 125 students will be accepted.—The Borden Company has made a \$1,500. grant to be used for undergraduate awards for pharmacy students.—Dr. Frank Crane, formerly of the University of Rochester, was appointed to the staff of the department of pharmacognosy as of May 1, 1951, to teach plant physiology.

The State University of Iowa.—Eleven students have recently been added to the Rho Chi membership.—Wanda Butler, James A. Conine and John R. Hohmann were elected associate members of Sigma Xi in May.—Thirteen prizes and awards for excellence in scholarship were awarded to students at the end of the academic year.—Mary Jane Vande Voort, associate hospital pharmacist in the University Hospitals, has resigned her position and will be married in August.—Ray I. Swart, associate, and Daryl L. Stamp, assistant hospital pharmacist, have been called to duty in the Armed Service.—Warren H. Meyer has been promoted from assistant to associate hospital pharmacist.—New appointments to the University Hospitals staff, effective July 1, include: William W. Tester, M.S. in Hospital Pharmacy, 1951, hospital pharmacist; Vern F. Thudium, B.S. in Pharmacy, 1951, and Donald J. Sieleman, B.S. in Pharmacy, 1951, assistant hospital pharmacists.—Dr. Robert L. Van Horne and Dr. Gail A. Wiese were promoted to assistant professorships on July 1.—Fifty-two seniors were graduated at the June Convocation.—A Beckman Quartz Apectrophotometer has been added to the pharmaceutical chemistry equipment.

University of Kansas.—Joseph Sam received the Ph.D. degree at the June commencement. His thesis title was "Synthetic Relatives of Cortisone". He has taken a position with the McNeil Laboratories in Philadelphia.—Charles S. Shull will complete work for the doctorate during the summer and will report in September at the North Dakota Agriculture College as associate professor of pharmacy.—Alpha Rho chapter of Rho Chi was installed on April 20th at Kansas by Dean J. B. Burt of Nebraska.—In the summer session, two students are registered

for the master's degree, and six for the doctorate. In addition there are two post-doctorate fellows.—Dr. Luther A. R. Hall, having completed a year as post-doctorate fellow, in June went to the DuPont Company at Wilmington. Dr. Verlin Stephens will go to the Lilly Research Laboratories, September 1, and Dr. Robert Meyer, an exchange student from Zurich, Switzerland, will take a position October 1 in the Parke, Davis Research Laboratories in Detroit.—The foundation is being laid for the new \$2,600,000 Science Hall in which the school of pharmacy will occupy the central part. The side wings will be occupied by the departments of chemistry and physics.—Chancellor Deane W. Malott ended a twelve-year tenure when he left the University July 1 to become president of Cornell University. At the annual alumni commencement dinner, he received his alma mater's highest award—the citation for distinguished service. He was cited for the enthusiasm he created for the University among faculty, students, and alumni.

University of Kentucky.—Prof. James W. Miles, associate in chemistry, is on a leave of absence for one year to complete work for the doctorate.—Dr. Harold C. Morris, associate professor of pharmacology, is on leave to do resident work at Hines Veterans Hospital, Hines, Illinois. Mr. Charles A. Walton, assistant professor of pharmacy, has assumed the teaching duties of Dr. Morris.

University of Maryland.—The annual meeting and entertainment of the alumni association was held on June 7, with 300 in attendance. The affair was in honor of the 1951 class and Dr. George A. Bunting of the Noxema Chemical Company, who was a member of the 1899 graduating class. Dr. Bunting was awarded the Alumni Prize as an outstanding member of the Alumni Association. The presentation was made by Dr. Carson P. Frailey, Vice-President of the American Drug Manufacturers Association. Dr. Bunting was Honorary President of the Alumni Association for the year 1950-1951 and was presented with the key of the Honorary President by President Frank Block. On this occasion, certificates of honor and prizes for scholarship were awarded to 11 seniors.—Anubhai H. Amin, Monte Konicov, Ludmila Kregiel, and Joseph Piala have completed work for the Ph.D. and William Heller and Agnes Wajert, for the master's.—Mrs. A. G. DuMez has provided for a memorial medal for Dr. A. G. DuMez for proficiency in Pharmacy.—Dr. Frank Slama, of the department of botany-pharmacognosy, has returned to Baltimore after spending a sabbatical year at Ohio State University.—Sixty-six seniors received the bachelor's degree at the June commencement.

University of Michigan.—The juniors and seniors visited the Parke, Davis plant in March and the Upjohn plant in May.—Delegates from twelve student A.Ph.A. branches attended the student District No. 4 convention in Ann Arbor on April 14 through 17. Fifty out-of-town students regis-

tered. Speakers included Secretary Robert P. Fischelis and Mr. Don Francke, President-elect of the A.Ph.A., Deans Tom D. Rowe of Rutgers University and Charles H. Stocking of Michigan, and a number of representatives of pharmaceutical industry, hospital and retail pharmacy.—On April 19, President Henry Gregg of the A.Ph.A. was the principal speaker at an all-pharmacy meeting sponsored by the Washtenaw County Drug Association.—On April 21, Alpha Chapter of Phi Delta Chi honored retiring Dean Charles H. Stocking with a banquet. Letters of congratulations from members of the fraternity from all parts of the United States were presented in bound form to the Dean.—At the University Honors Convocation, scholarship awards were announced for eight pharmacy students and the election of four students to Rho Chi; five to Phi Kappa Phi; three to Phi Lambda Upsilon; and one to Alpha Lambda Delta. Six students were named for scholastic honors.

University of Minnesota.—Eighty students visited the Lilly Laboratories in March.—Seventy seniors were graduated at the June commencement. Miss Li-Chin Chiang received the Ph.D. and Col. L. P. Zagelow, the master's.—Four juniors and one graduate student were initiated by Rho Chi in May and five seniors were recently initiated by Lambda Upsilon.—At the conclusion of the annual meeting of the Minnesota State Pharmaceutical Association on April 3, Dr. W. J. Hadley was continued as secretary and Dr. C. V. Netz, as retiring president, became a member of the executive committee. He was presented with an Omega wrist watch and a framed scroll in appreciation of his services as president.—Lt. Col. Leonard P. Zagelow, United States Air Force (MSC) has concluded his three-year tour of duty as Professor of Military Science and Tactics in charge of Pharmacy ROTC training program and on July 1 he reported for duty as officer in charge of the Requirement and Stock Control Branch, Office of Surgeon General, Brooklyn, N. Y. He was replaced by Capt. W. C. Luers, MSC, United States Army, who was transferred from the Medical Field Service School, San Antonio, Texas.—Prof. C. E. Smythe, who retired from the faculty July 1, had a number of testimonials given in his honor and was presented with a wrist watch by Kappa Psi, and a fine camera by the senior class.—On May 5, eight pharmacy seniors were among a group from all colleges of the university which was honored at a Court of Honor dinner given by various Minneapolis civic groups.—At the Centennial Cap and Gown Day Convocation on May 24, scholarships and prizes were awarded to fourteen students for scholarship excellence.—Fifteen seniors received commissions as Second Lieutenants in the Medical Service Corps of the U. S. Army or U. S. Air Force, after having completed their training period in the Pharmacy ROTC.

University of Mississippi.—Fifty-four students were granted the bachelor's degree at the June commencement.—Ten new members were initiated by Rho Chi in April.—Four pharmacy students were recog-

nized because of their scholastic achievements at the university's annual Honors Day convocation.—Four other students were given prizes for high scholarship.—One hundred students are enrolled for the first six-weeks term of the summer session.

Montana State University.—Prof. Tracey G. Call has taken leave of absence for the next academic year to complete work for the doctorate at the University of Minnesota.—Profs. G. H. Bryan and F. C. Hammerness will carry graduate work the coming year, the former at the University of Maryland, and the latter at the University of North Carolina.—Dr. Witold Saski and Dr. Muriel Loran, a recent graduate of Ohio State, have been appointed to assistant professorships in pharmacy and Miss Hazel Landeen has been given a temporary assistant professorship replacing Prof. Call during his leave.

University of Nebraska.—A reunion dinner of the Nebraska and Creighton University chapters of Rho Chi was held on April 16.—Paul Lish from Nebraska and George Blonder from Creighton represented the Rho Chi chapters in a discussion on "New Drugs in U.S.P. XIV" before the State Pharmaceutical Association in April.—Kappa Epsilon sent three representatives to the national convention at Iowa City in April.—In April, Dean and Mrs. J. B. Burt attended the installation ceremony for the Alpha Rho chapter of Rho Chi at the University of Kansas.—Dean Burt represented the officers of the American Association of Colleges of Pharmacy at the Seventh District annual meeting at Pocatello, Idaho, in May.—The senior class had charge of the Open House display in the pharmacy building as a part of the University's College Days program.—The Lincoln Drug Company and the Smith-Dorsey Company gave complimentary dinners in honor of the graduating class in the closing days of the school year.

University of New Mexico.—A group of juniors and seniors visited the Eli Lilly Company recently.—Dr. LeRoy Miller, a local neuro-surgeon has been engaged as lecturer in pharmacology during Dr. Hocking's leave of absence.—The annual banquet honoring the seniors and sponsored by Kappa Psi, was held on May 11.—Kappa Psi announces sixteen new initiates.

University of North Carolina.—Forty-seven seniors were graduated at the June Commencement.—Yen-tsai Chang received the Ph.D. degree and Benjamin F. Cooper the M.S. degree.—Prof. I. W. Rose has retired after twenty years of service to the institution.—Awards for excellence in scholarship have been awarded to seven pharmacy students.—Courses in pharmaceutical preparations, inorganic pharmacy, pharmaceutical chemistry and dispensing are being given during the summer quarter.

North Dakota Agricultural College.—Dean and Mrs. W. F. Sudro attended the meeting of District No. 5 at Rapid City, South Dakota in June.—Fifty-seven seniors were graduated at the June commencement.—Experimental work is being carried out with several medicinal plants this summer at the experimental farm. Interest is centering around buckwheat and annual and perennial wormwood.

Ohio Northern University.—Former Dean Rudolph H. Raabe has now been given Emeritus status and will continue to teach courses in pharmacology, theoretical pharmacy, and pharmaceutical arithmetic.—Three new instructors have been added to the staff. All have had some teaching experience and all have the master's degree. Mrs. Matty Jone-ward, who came from the University of Kentucky College of Pharmacy, heads the Division of Pharmacy. Mr. Fred Clark from Upper Iowa College, who formerly taught pharmacognosy at Ferris Institute and Detroit Institute of Technology, heads the Division of Pharmacognosy. Mr. Theodore Schlosser has the master's degree from Washington State College and has had two years teaching experience and retail drug store experiency in Idaho, heads the Division of Pharmaceutical Administration.—New equipment is being installed for a combination bacteriological and biochemistry laboratory. A small manufacturing laboratory with a few power machines has been started on an exploratory basis suitable for future development. Prof. Clark is developing a physiological laboratory sufficient for at least one semester's work and equipment is being added to help demonstrate and in some cases assign work in pharmacology.—On the last Thursday in April, open house was held for the Northwestern Ohio Druggist Association and dinner was served at the Kappa Psi fraternity. In the evening the Association, students and townspeople attended a lecture on "Socialized Medicine" by Judge Homer Ramey of Toledo, who was a former Ohio congressman and one of the members of Congress that visited Europe and Russia.

University of Oklahoma.—Forty pharmacy alumni and friends attended the alumni convention of the Oklahoma Pharmaceutical Association in Tulsa. The meeting was notable because an atmosphere of friendliness and a desire to enlarge the organization which was manifested. A constitution was read and approved and plans laid for the future. Steps were taken to help hospital pharmacists in Oklahoma organize as a branch of the American Society of Hospital Pharmacists, Progress toward the objective is being made.—Dr. Cecil P. Headlee, who had his graduate training at Purdue, has been appointed as assistant professor of pharmacognosy.—Prof. William G. Bray has been called to active service in the Air Force.—A large stock of new drugs is now in the University Pharmacy. Literature is being added systematically and is used by students and open to druggists of the state when they care to use it to acquire late information. The new manufacturing

laboratory is an asset to student instruction and may be of service also to pharmacists in manufacturing and compounding problems.—Dean Ralph W. Clark has been appointed to the Executive Committee of the Oklahoma Medical Research Institute and Chairman of the Pharmaceutical Research Committee.—Dean Clark and other members of the staff have been active in addressing professional and civic organizations throughout the state during the academic year.—Mr. Henry Gregg, president of the A.Ph.A. addressed the student branch in April.—Recently a Dean's Honor Roll has been established by faculty action to include those students with a B or better average during the previous semester. Thirty of the 231 students made the roll the second semester and the parents and the home town newspapers have been notified of the accomplishment of each student.—Prof. Jean Brown is taking courses in manufacturing pharmacy at Purdue this summer and Prof. Blanche Sommers is attending Oklahoma University taking courses preparatory for graduate work in pharmacy.

Oregon State College.—The annual school picnic sponsored by the student branch was attended by more than 200 students.—“Growth of Pharmacy at Oregon State College”, a two page pictorial feature, was the leading article in the May issue of the alumni magazine, *The Oregon Stater*.—At the all-college honors and awards convocation, seven pharmacy students were mentioned as honor students, three of them were elected to Phi Kappa Psi.—Fifty-one degrees were awarded at the commencement ceremonies: 48 were bachelor's in pharmacy, 2 received bachelor of arts, and one the master's in science.—Helen Briscoe, an outstanding pharmacy senior, was chosen to read the scripture message at the baccalaureate services in Gill Coliseum on June 4.—Lt. Gordon B. Stirland, j.g., U.S.N.R., who received the master's degree in June has been recalled to active duty with the Navy.—Over 1600 trade-size packages of pharmaceutical products were donated to the school during the last academic year by manufacturers. These products are placed in the model pharmacy and used by the seniors in the prescription compounding laboratory.—Dean George E. Crossen has been elected vice-chairman of the Benton County, Oregon, chapter of the American Red Cross.

Philadelphia College of Pharmacy and Science.—A chapter of Rho Chi (Alpha Tau) was installed on May 10. The officer in charge at the installation was Dr. Paul Jannke of the Connecticut College of Pharmacy.—The Alumni Association gave a dinner on May 24, honoring Dr. Ivor Griffith and commemorating the completion of his tenth year as president.—At the June commencement, 210 degrees in pharmacy, in chemistry, and in bacteriology were granted. Four honorary degrees of Doctor of Science were granted. The recipients were George F. Archambault, chief pharmacist, Hospital Division, U. S. Public Health Service; William W. Hosler, Vice-president in charge of research and

control, Strong Cobb Co.; Hugo H. Schaefer, Dean, Brooklyn College of Pharmacy; and George F. Smith, President of Johnson and Johnson.—Six scholarship awards were made to undergraduates and graduate students on April 11.—As a service to physicians, the Philadelphia Fellows of the American College of Apothecaries are sponsoring a series of monthly articles in *Philadelphia Medicine*, the official publication of the Philadelphia County Medical Society. The department of pharmacy of the college is responsible for the preparation of these presentations of authoritative information about modern drugs and the best techniques for prescribing or using them.

The University of Puerto Rico.—The chemistry and physics departments which now occupy a part of the space in the pharmacy building will soon move into the new science building. The pharmacy library, the historical museum, and a research laboratory will use the vacated space.—The pharmacy course has been increased to five years; one year a basic course and four years in the college of pharmacy.—Mr. Leo B. Lathroum, from the college of pharmacy of the University of Maryland has been added to the teaching staff.—Dr. Charles O. Lee who was a visiting professor at this college last year has returned to Purdue.—Patrick Henry Grenshaw was awarded the Gold Medal by the Puerto Rico Pharmaceutical Association for the highest scholastic average during the last academic year.—More than 50 members of the student branch and the faculty went on a field trip in June to El Yunque which is Puerto Rico's highest mountain peak.

Purdue University.—Eighty-six students visited the Upjohn and Parke, Davis plants in April.—Mr. Ravindra G. Baxi, M.S. '49, is now senior chemist at the Naffkine Institute, Bombay 12, India.—Ivar Danielsson, Ph.D. '47, is government inspector of apothecaries, professor at the Iceland School of Pharmacy, and consultant to Iceland State Medicine in Reykjavik, Iceland.—Kennie M. Linn, M.S. '45, is now superintendent of the All India Missions Tablet Industry in Bowringpet, India.—Dipendra S. Guha, M.S. '50, is medical representative for Parke, Davis in Bombay, India.—Drs. John E. Christian and Glen J. Sperandio have been appointed to sub-committees on Revision of the National Formulary to assist in the preparation of the Tenth Revision.—Dr. Christian has been named on the Radiological and Chemical Defense section of the Department of Civil Defense for the state of Indiana.—A course in "Radiography of the Pelvis and Spine", sponsored by the School of Pharmacy in cooperation with the General Electric X-ray Corporation, was held in May. Attending were members of the medical profession and their sponsored associates.

Rhode Island College of Pharmacy and Allied Sciences.—Twenty-nine seniors received the bachelor's degree at the June commencement. The Honorary master's degree was awarded to Raymond Charles

Vars and the honorary degree of doctor of science was granted David Lichtman, M.D., and to Harold William Browning, Ph.D.—Eight students were awarded prizes for superior scholarship.—President Albert Claflin gave the commencement address.

Rutgers University.—Dr. Roy A. Bowers assumed the deanship at Rutgers July, 1951.—Dr. R. A. Deno will return in September to resume his duties as professor of biological sciences.—Mr. Louis Kazin, director of the Rutgers Pharmacy Extension Service, has made 536 personal store visits in 1950, in which he made a definite contribution to store operation. Sectional business and professional conferences have been made in five areas of the state. These conferences have been attended by 36% of the store owners in these areas. Vol. 11 of the Pharmacy Extension Newsletter began in June 1951 and has had a great deal of reader interest.—A farewell dinner was given by the staff for Dean and Mrs. T. D. Rowe on the eve of their departure to their duties at the University of Michigan. The staff's parting gift was a silver table lighter set.

Southern College of Pharmacy, Inc.—Dr. Minnie M. Meyer, Profs. J. N. Sedor and A. F. Morgenthaler, and Mr. W. C. Davies attended the dedication of the new pharmacy laboratories and the annual dinner at the University of Georgia in May.—Prof. Morgenthaler has taken a year's leave of absence to continue his studies at the University of Florida.—A chapter of Phi Delta Chi was established at the school on May 26, 1951 and a petition has been filed for a chapter of Kappa Psi.—Five women and 63 men were graduated on June 21.—The alumni association is establishing an R. C. Hood Foundation Fund and the students have pledged their support to the fund raising campaign. The graduating class has set a goal of \$1,000 and the remaining classes, one of \$1,100.—On June 22, 1951, the faculty, alumni, students and friends of the college held a recognition dinner for Dean Emeritus R. C. Hood who was one of the founders of the school and has given it 48 years of his time and service.

St. Louis College of Pharmacy.—Ninety-three seniors were graduated in June.—The new O. J. Coughly-Alumni Library was formally dedicated on May 9.—The refresher course for practicing pharmacists was held in conjunction with open house day. More than 600 persons attended the open house festivities; 188 registered for the refresher course.—A chapter of Lambda Kappa Sigma, pharmaceutical sorority, with 17 charter members has been established at the college.—The senior class this spring visited the Upjohn and Parke, Davis plants.—The following promotions have been made: Dr. Frank L. Mercer and Dr. Arthur G. Zupko to the rank of associate professor and R. E. Dietzschold to the rank of assistant professor.—Pi chapter of Kappa Psi has created an annual scholarship of \$50 to be given to an out-

standing student, not necessarily a member of the fraternity.—The Alumni Association is to have a new private office in the college building.—The college is offering a full semester's work during the summer of 1951.—Dr. Carl J. Klemme, professor of industrial pharmacy, has resigned in order to accept a position in industry.

Temple University.—The school of pharmacy celebrated the fiftieth anniversary of its founding on April 11. Dr. Detlev W. Bronk, president of Johns Hopkins University was the speaker at the convocation attended by 750 students and alumni of the school. Dr. Bronk's subject was, "Research—Pathway to a Better Life". Honorary degrees were awarded President Bronk and Commander W. Paul Briggs of the Medical Service Corps, U. S. Navy.—A symposium, "Twentieth Century Pharmacy After Fifty Years," followed the convocation. Speakers at the symposium were Mr. Robert L. McNeil, president of McNeil Laboratories, Inc.; Dr. Charles F. Gilson, president of the National Association of Retail Druggists; and Dr. Hugo H. Schaefer, Dean of Brooklyn College of Pharmacy and president of the American Association of Colleges of Pharmacy. During the afternoon ceremonies, Mr. Henry V. De Haven, vice-president of the Philadelphia Wholesale Drug Company, presented Vice-President Tomlinson of the University with a key to a model pharmacy, erected on the fourth floor. The pharmacy, complete in every detail, is fully stocked with drugs and supplied with the latest in equipment. At the fiftieth anniversary dinner held during the evening, members of the first two graduating classes were honored. Robert K. Pentland of the class of 1904, and Robert T. Deveraux, Daniel E. Maloy, and Patrick J. Maloy, of the class of 1905, were awarded medals by Dean Sprowls.—At the June commencement, 81 students were awarded the bachelor's degree and 6, the master's and prizes were given to 5 students for superior scholarship.—Dr. David E. Mann, Jr. is giving a course in physiology at Purdue during the summer session.

University of Texas.—Sixty seniors were graduated at the June Commencement.—Dr. Melvin A. Chambers has been granted leave for one year to continue studies and research at the Oak Ridge Institute for Nuclear Research.—The pharmacy faculty has petitioned the Graduate Council of the University for permission to approve a program leading to the granting of the doctorate.—Dedication ceremonies for the pharmacy building now under construction, have been set tentatively for April 3, 1952.—Dr. C. C. Albers attended the semi-annual meeting of the Board of Education of the United Lutheran Church in America in Washington, D. C., on June 19-20.—Two hundred twenty-five undergraduate and five graduate students are enrolled in the summer session.—Profs. Mittelstaedt and Albers spoke to a number of high school classes in sociology on the subject of narcotics during the last semester.

Medical College of Virginia.—The staff cooperated in a seminar on "The Pharmacist's Role in Civil Defense" which was held in the Rich-

mond Academy of Medicine in March. Chief Pharmacist, Russell Fiske spoke on the role of the hospital pharmacist in the event of an emergency; Dr. Herman Nachman gave a presentation on the medical aspects of atomic bombing with emphasis on the problem of burn injuries; and Prof. F. P. Pitts discussed radiological defense in which he spoke of the introductory aspects of atomic energy and nuclear fission.—Dr. R. B. Smith, Jr., attended the meeting of the Federation of the American Societies of Experimental Biology at Cleveland in May.—Dr. M. L. Neuroth, third grand vice-regent of Kappa Psi addressed Mu Chapter and the Graduate Chapter of the Massachusetts College of Pharmacy at the annual banquet on April 10.—Drs. John Boenigk and M. L. Neuroth, with the cooperation of the pharmacists of the state, are conducting a prescription survey of Virginia.—The Junior and senior classes visited the Parke, Davis plant in March.—The annual pharmacy banquet, sponsored jointly by the Mortar and Pestle Club and the Rho Chi society, was held on May 10. Winners of prizes for scholarship during the academic year were announced.

The State College of Washington.—Dr. Wilson Compton, president of the State College has resigned, effective September 15, 1951.—Dr. A. I. White is serving as a member of the committee of the regents, faculty, students and alumni in the selection of a new president. Dr. White was also recently elected to the Faculty Executive Committee, the function of which is to represent the faculty in matters dealing with the administration.—Dr. Gertrude Horn Reavis has resigned her position as assistant professor of pharmacy in order to devote her time to her home and assist her husband who operates a pharmacy in Pullman.—Mr. Laurence Gale, a graduate of Idaho State College, is registered for graduate work in pharmacology.—A considerable amount of equipment has been added to the new pharmacologic laboratory.

The University of Washington.—The master's degree was recently granted to Muriel C. Vincent and to Stephen Sim, and the doctorate to D. P. N. Tsao.—Eighty seniors took the Washington State Board immediately after graduation. Approximately 15 of them will be called to the Armed Services.—Additional space for research will be available with the remodeling of the third floor. Chemistry will share the added space.—Dean Goodrich and Drs. Rising and Fisher have been busy giving talks to various groups throughout the state.—Dr. Rising represented the college at the dedication of the University of British Columbia Pharmacy Building. He also represented the school at the diamond jubilee of the British Columbia Pharmaceutical Association.—Dr. Fisher, in his capacity as First Grand Vice Regent of Kappa Psi, visited the collegiate and graduate chapters of Province VII. Dr. Fisher will direct the campus Community Chest drive.—Spending the summer doing graduate work under various members of the pharmacy staff are: Prof. Alexander Wood from the University of Saskatchewan; Prof. Arthur

J. Anderson from the University of Alberta; and Profs. J. N. Bone and Raymond J. Kahl from the University of Wyoming.—Sigma Xi has accepted Roy Hammarlund and E. H. Djao into full membership and J. N. Bone, Timothy Ho, K. C. Varma and Stephen Sim as associate members.—Dr. Nathan Hall has been appointed research chemist under a grant made available by initiative 171. He will devote full time to research designed to benefit the wine industry.

Wayne University.—A grant of \$30,000 has been provided Wayne University by Parke, Davis and Company to furnish and equip a pharmacy laboratory in the University's Old Main building.—The upper classmen and faculty members recently visited the Parke, Davis and the Lilly plants.—Dean Lakey attended the 10th anniversary of the founding of the American Institute of the History of Pharmacy at the University of Wisconsin on May 10.—Six senior students demonstrated the uses of special types of equipment from the pharmacy, pharmaceutical chemistry, and pharmacology laboratories over the University's television on June 16.—Dr. Harold E. Bailey attended the meeting in Cleveland recently of the American Association of Bacteriologists.

University of Wisconsin.—Remodeling is being completed to enlarge the main office and to increase office space for the staff; manufacturing laboratory facilities will be enlarged and a new pharmacy development laboratory installed.—Ninety-two seniors graduated in June; one Ph.D. was granted and four M.S. degrees, including a pharmacy graduate student majoring in marketing (School of Commerce).—Lt. Melvin W. Crotty, a graduate of the Massachusetts College of Pharmacy, will head the pharmacy ROTC unit, replacing Maj. Ralph Arnold, who is being transferred after receiving an M.S. in pharmacy.—Dr. George Urdang has been elected to an honorary membership in the Deutsche Pharmazeutische Gesellschaft, an honorary membership in Kappa Psi, and a corresponding membership in the Mexican Society for Natural History.

University of Wyoming.—Nine pharmacy students won the distinction of being on the University Honor Roll for the winter quarter.—Two pharmacy students, Kenneth Neilsen and Joe Toland have been elected to Phi Kappa Phi.—Dean David W. O'Day was a guest speaker at the Training Assembly of the 5011th Reserve Officers Research and Development Unit in Laramie in April. His subject was "New Weapons in Medicine".—Prof. Ramona A. Parkinson of the pharmacy department has been elected as an associate member in Sigma Xi.—Mr. Rand P. Hollenback, National Secretary of Phi Delta Chi, was a campus visitor on April 27. Six candidates were initiated into the chapter on May 11.—An electrically operated capsule filling machine, a special torch ampul sealing apparatus, and a telephone intercommunication system have been added to the equipment of the dispensing laboratory.—

Scholarship awards were made to five pharmacy students at the University's Honor Convocation in May.—The students prepared a special display in the Student Union Building for the three-day convention of the Wyoming State Nurses Association in June. The display extended greetings to the nurses as co-workers of the pharmacists and doctors in the public health field and illustrated the functions of the pharmacist in that field.

Xavier University.—The students in pharmacology presented a demonstration of the action of certain drugs on the mammalian intestines at the annual meeting of the Louisiana Pharmaceutical Society on May 9.—The Progressive Druggists Association of New Orleans has established a student scholarship fund for pharmacy students at Xavier. The I. L. Lyon and Company of New Orleans, was the first donor.—The student branch was formally presented its charter by Mr. Joseph Lucas, president of the Louisiana Board of Pharmacy, on April 18.—Joseph A. Azemard, instructor in pharmacognosy and pharmacology has taken a leave of absence for the coming year to continue graduate studies at the University of Southern California.

The Health Information Foundation has completed an analysis of a multiple screening program in Richmond, Virginia. Multiple screening consists of a series of tests for pathological conditions among apparently well people. The tests are generally given by technicians but the results are sent to each individual's physician for diagnosis.

About 40,000 people attended the Richmond Clinic where examinations were given for tuberculosis, heart defects, syphilis, hypertension, anemia, diabetes, obesity, visual impairments.

For the purpose of the analysis, the Health Information Foundation's research team secured information from nearly 1,600 people in Richmond. Different groups were interviewed as they entered, as they left, and several months after they had attended the clinic. Other groups providing data were local physicians and industrial health workers in the Richmond area.

The emphasis in this research was to secure information that would be useful not only to Richmond health leaders, but to leaders in other communities or industries which are considering multiple screening programs.

The Health Information Foundation is publishing a report of this research which may be obtained without charge as soon as it is available. Readers desiring a copy may write to the Foundation at 420 Lexington Avenue, New York 17, N. Y.

Miscellaneous Items of Interest

A MEMORIAL

CLIFFORD WARREN CHAPMAN

Dr. Clifford Warren Chapman, Emerson Professor of Pharmacology in the School of Pharmacy of the University of Maryland, passed away on April 5, 1951.

Dr. Chapman came to the University of Maryland in 1938 from the Laboratory of Hygiene, Department of Pensions and National Health of Canada, which department is in charge of drug control work in the Dominion, and in which he held the position of pharmacologist.

Dr. Chapman was born in London, Ontario, October 18, 1896. He did his under-graduate work in the University of Western Ontario from which he received the B.A. degree in 1922. He majored in Biochemistry for the M.Sc. degree, which he received in 1925 from the Medical School of Ontario. He received the Ph.D. degree in 1934 from McGill University where he specialized in pharmacology and biochemistry. He also pursued graduate work in the Department of Biochemistry of the University of Chicago. While still a graduate student, he served as Instructor in Chemistry in the University of Western Ontario and in the Medical School of Ontario. Subsequently, he was employed as chemist and bacteriologist in the Institute of Public Health of Ontario, as an analyst in the clinical Laboratory of the Army and Civilian Hospitals of Canada, and as Instructor in Biochemistry in McGill University. He served as bioassayist for the Department of National Health of Canada for ten years.

Dr. Chapman's research work was primarily in the fields of biochemistry and pharmacology. He carried on research studies in the biological assays of the arsphenamine group, pituitary extract, ergot, thyroid, epinephrine, hormones, etc. The Canadian Standards for Digitalis, Pituitary Extract, Epinephrine, and Ergot were prepared by Dr. Chapman.

The professional affiliations of Dr. Chapman included the American Pharmaceutical Association and the Federation of Biological Societies. He was especially interested in the Society for Experimental Pharmacology. In addition, Dr. Chapman was a member of the General Committee of Revision of the United States Pharmacopoeia from 1940 to 1950 and during this same period served on the Subcommittee on Biological Assays and the Subcommittee on Biological Products and

Diagnostic Tests. He was also a member of Sigma Xi, Rho Chi, Phi Delta Chi, and was a member of the Masonic Lodge.

Dr. Chapman is survived by his wife, Mrs. Effie Chapman, and two children, Mrs. Bobb Murray Stevens and Mr. Wilson Chapman.

Abstracts of the Minutes of the Meetings of the American Foundation for Pharmaceutical Education and of the Board of Directors, held at the University Club, New York City, May 17, 1951.

The meeting of the members was called at 10:40 A.M. by President C. S. Beardsley.

Acting Secretary Ernest Little presented a written report in which he recorded the activities of the Foundation in recent months. He offered suggestions concerning the opportunities for service which lie ahead and expressed confidence in the Foundation's program. It was ordered that the Acting Secretary's report be appended to the minutes and made a part of the record.

After passing upon routine business the meeting was adjourned for a meeting of the Board of Directors which was to follow immediately.

President Beardsley called the meeting of the Board of Directors at 11:30 A.M.

The President gave a brief informal report in which he expressed great confidence in the new Director, Dr. W. Paul Briggs. He referred to the new office at 1450 Broadway as being both pleasant and practical and expressed confidence as to the future of the Foundation.

Treasurer S. B. Penick, Sr., expressed the opinion that the Foundation should build up and maintain an unexpended balance of at least \$1,000,000. He said that he anticipated that the collection for 1951 would be not less than \$130,000. He stated that although it has been necessary for the Foundation to sell \$50,000 of government securities last year, we still held government securities valued at \$630,000 and that the Foundation was in excellent financial condition. He stated that the Foundation had the united support of the drug industry and that within five years we might be expending \$500,000 a year in behalf of the over all profession of pharmacy.

Mr. Penick had announced that he could no longer carry the burden of the treasurership which he has held since the beginning of the Foundation. He was a charter member of the Foundation and in addition to his other duties he had served as chairman of the finance committee since the organization of the Foundation. President Beardsley appointed a committee (Swain-Little) to draw up suitable resolutions commemorating Mr. Penick's service from which we quote as follows:

"This statement is no formal resolution, such as is extended to men when their work is done. It is a sincere expression of thanks to Mr. Penick's interest in, and continued contributions to the American Foundation for Pharmaceutical Education.

"We ask that he accept our sincere gratitude for his efficient services of the past. We express the hope that he may continue as an active member of the Board of Directors, so long as he may live.

"**Be it resolved**, that this statement be spread upon the Minutes of the 1951 Annual Meeting of the American Foundation and respect for an unusually faithful and efficient co-worker, Mr. S. B. Penick."

The statement and resolution was officially adopted as an official Board of Directors' resolution.

By action of the Board, Dr. W. Paul Briggs was unanimously appointed Executive Director of the American Foundation for Pharmaceutical Education in charge of the Foundation office and to assume general direction of all Foundation affairs, operating within such limitations as may be laid down by the Board of Directors or the Executive Committee.

Then followed the election to and appointment of committees, elections to the Board of Grants and election to the Board of Directors. As these items appear in "**A History of the American Foundation for Pharmaceutical Education**" appearing in this issue of *The Journal*, they are not recorded here.

An offer, through Chairman S. B. Penick from the Committee on the Edwin Leigh Newcomb Memorial Fund, to turn over to the Foundation the \$16,545.05 collected by that committee, provided the Foundation appropriates a like amount to make a total of \$33,090.10, was unanimously approved. Means were taken to guard the principal of the fund so as to use the income for the purposes originally intended, namely, to encourage study and research in pharmaceutical botany and pharmacognosy.

A considerable amount of routine business was disposed of and a number of suggestions and recommendations were sent to various committees for further study and recommendations.

The meeting adjourned at 4:15 P.M. and the minutes were signed by Ernest Little, Acting Secretary.

New American Foundation for Pharmaceutical Education Fellowships

Executive Director, W. Paul Briggs, has just released the following information:

On June 18 the Board of Grants of the American Foundation for Pharmaceutical Education selected 25 new Fellows for graduate study in pharmacy and related fields at eighteen universities and colleges.

Members of the Board of Grants are Dr. Guy Stanton Ford, Chair-

man; Dr. A. J. Brumbaugh, Mr. Charles J. Lynn, Dr. Ernest Little, and Mr. James Hill, Jr.

The 25 new Foundation Fellows were selected from 103 applicants. The Board plans to meet again before the next academic year begins if it is found possible to increase the number of new Fellowship awards. However, if the Board selects any additional Fellows to start their studies in September, 1951, it will do so from among the present applicants, since many of these are fully qualified but could not be selected because of present budget limitations.

The Board also approved a program of undergraduate scholarships available to every accredited college of pharmacy.

The new Fellows of the American Foundation for Pharmaceutical Education are: Byron A. Barnes, Joseph G. Cannon, William D. Cash, Kenneth I. Colville, Aaron D. Cooper, Norris W. Dunham, Allan E. Dyer, William D. Easterly, Richard E. Faust, Jr., Frank M. Ferraro, Laurence E. Gale, Arthur C. Glasser, David H. Gregg, Wallace L. Guess, William M. Heller, Henry D. Johnson, Martin Katz, Kenneth J. Liska, Robert C. Mason, Harold J. Rhodes, Carl C. Riedesel, Jacob S. Rodia, Homer C. Scarborough, Jr., Albert C. Yard, Harold Zinnes.

Mr. Richard E. Faust will hold the recently created American Pharmaceutical Manufacturers' Association grant.

The Board also acted upon most of the applications for renewal of grants to Foundation Fellows already studying at 21 universities and colleges.

Convention Program of the American Institute of the History of Pharmacy, Buffalo, N. Y., August 31, 1951

1. "The First Ten Years of the American Institute of the History of Pharmacy."—George Urdang
2. "A Short History of Glycosides"—G. R. Paterson
3. "Was the Sugar-Coated Pill an American Invention"—Glenn Sonneck
4. "Development of the College of Pharmacy at the University of the Philippines"—Jesusa Concha
5. "C. S. Rafinesque and American Pharmacy"—Alex Berman
6. Business Meeting.

New Books

Art And Pharmacy.—A collection of 42 reproductions, published in the Dutch pharmaceutical calendars, with an introduction by Dr. D. A.

Wittop Koning, Pharmacist at Amsterdam. "De Ysel" Press Ltd.—Deventer, Holland, 1950. 26 x 26 cm. Price, \$5.00.

This is quite an unusual appearance on the book market. Dealing with art devoted to pharmacy it offers in forty-two colored pictures of the highest possible technical perfection a most appealing insight into conceptual (patron saints) as well as factual pharmacy through the ages supported by an excellent general introduction and brief but pertinent legends to the individual pictures. Besides, it represents a fitting memorial to the meritorious pharmaceutical scientist and collector with whom the idea of these pictures and their presentation originated; the late Professor of Pharmacy at the University of Amsterdam, Pieter van der Wielen (1872-1947).

The introduction, written by the practising pharmacist and lecturer of the history of pharmacy at the University of Amsterdam, Dr. D. A. Wittop Koning, a masterpiece of concise statement, explains the 42 pictures within the framework of a general appreciation of the pharmaceutico—historical work of Professor van der Wielen. It was in 1939 that Pieter van der Wielen produced the first of the series of calendars with reproductions in color which have since been published by the Dutch Society for the Promotion of Pharmacy (Koninklijke Nederlandsche Matschappij Ter Bevordering Der Pharmacie).

Since then, until 1950, fifty-four pictures have been published in these calendars, the last two of which were arranged by Mrs. van der Wielen, like her late husband a pharmacist and his most helpful companion in collecting, examining and preserving the items of the remarkable museum housed in her home at Hilversum. Not less than 12 of the pictures from these calendars and republished in "Art And Pharmacy" are reproductions of items from the van der Wielen museum.

The book has appeared in four languages, Dutch, French, English, and German. The legends to the individual pictures in all editions are in all four languages, while the introduction appears in one of the languages only. It may be mentioned that individual pictures for framing can be ordered from "De Ysel" Press Ltd., Deventer (Holland) for a very reasonable price, 35 cents U.S.A. money.

It is to be hoped that this beautiful as well as significant publication will be followed by others of the same kind.—George Urdang.

History of Pharmacy by Edward Kremers, Ph.G., Ph.M., Ph.D., late Director, Course in Pharmacy and Professor of Pharmaceutical Chemistry, University of Wisconsin, and George Urdang, Ph.G., D.Sc., Nat., Sc.D., Professor of the History of Pharmacy, University of Wisconsin, and Director of the American Institute of the History of Pharmacy. Second Edition, revised and enlarged. 1951. 622 pages. 30 illustrations. J. B. Lippincott Company. Price \$7.50.

Historical research, like research in science, discovers new facts which change both our thinking and the significance of facts and view-

points that have been considered settled for some time. During the last decade studies in the historical area have been extensive. However, in preparing the Second Edition of the Kremers-Urdang History of Pharmacy, Dr. Urdang found that it was not necessary to deviate from the pattern laid down for the writing of the First Edition. This is proof of the soundness of the plan. More recent events demanded inclusion in the text and made necessary a complete revision and enlargement. No effort was spared to check the data in every chapter for historical accuracy. In the chapters on the development of pharmacy in England and in France, the author had the assistance of the outstanding historians of the respective countries. A chapter on the development of pharmacy in Spain has been included. This completes the missing link in pharmacy's development from the Ancient Civilizations up through Europe and England and across the sea to the North American Colonies.

For many years teachers clamored for a suitable guide for the teaching of historical pharmacy in the class room. This need was felt most keenly by the teachers themselves, few of whom had had any formal training in the subject. The First Edition of the text supplied the guide. The Second Edition remains a guide, but it is more than that. The author, in the first place, has saturated the chapters with sub-titles so that the student knows when he begins a paragraph what he is to learn about. For example, take a part of Chapter One which deals with the development in Greece and Rome. In the original edition there were no sub-titles. In the present edition there are the following: The Beginning of Greek Medicine; Philosophy and Its Influence on Medical Concepts; Hippocrates; The School of Alexandria; The Rhizotomoi; Pliny Galen; Retail Trade in Drugs; Two Roman Authors of Medicine and Pharmacy; The End of the Epoch.

When the author jumped the Atlantic he followed the same plan. The chapter on the North American Colonies has the following sub-titles and lesser divisions: The Spread of the European Settlements; Development of Pharmaceutical Practice, (a) The Origins (b) New Spain, (c) New France, (d) New Sweden and New Netherlands, (e) New England; Colonial Drug Stores in the Eighteenth Century; Colonial Legislation Pertaining to Pharmacy; Attempted Separation of Pharmacy from Medicine. Moreover, the author has integrated pharmaceutical history into contemporary American history to such a degree that as a student studies the history of his profession, he studies the historical development of his own country.

In the second place, each subdivision of a paragraph is so complete in itself that it can be read with profit when taken out of context. Like biblical truths, the history of pharmacy is so extensive that it can be grasped only by piecemeal. Dr. Urdang has made every section or sub-section of the book an entity so that the reading of any

part is an inspiration and a morale builder for both student and practitioner. In the hands of the master the text has become a classic in pharmaceutical literature. The publishers are to be commended for excellence of type which makes reading easy.—R.A.L.

Pharmacognosy, The Study of Natural Drug Substances and Certain Allied Products by Robertson Pratt, Ph.D., Associate Professor of Pharmacognosy and Plant Physiology, University of California, College of Pharmacy and Heber W. Youngken, Jr., Ph.D., Associate Professor and Chairman for Pharmacognosy, University of Washington, College of Pharmacy. 1951. 644 pages. 67 illustrations including 4 plates in full color. J. B. Lippincott Company. Price \$8.50.

At last we have a new text in a subject that "is as old and as modern as civilization". The approach, the contents, the viewpoints, and the objectives are to a very large extent new. As the authors have well said, 'The scope of modern pharmacognosy is such, however, that it can no longer be described merely as 'the science of crude drugs'. The study of natural drug substances is a functional science at the very core of pharmacy, permeating as it does into phases of dispensing pharmacy, of pharmaceutical chemistry, of pharmacology and of physiology. Therefore, pharmacognosy is a common meeting ground for physiochemical and biologic sciences. It is a descriptive and experimental science. But above all, it is functional, living, and growing.' The contents of the text will be best appreciated by a recital of its six sections which are: General Aspects of Pharmacognosy, Definitions and Sources of Drug Materials; An Introduction to Cellular Chemistry; Utilization and Classification of Drugs; Biosynthetic Products and Certain of Their Derivatives—Physiological and Pharmaceutical Applications; Practices and Procedures; Pest and Weed Control—Problems in Public Health. The text presents a new era in pharmacognostic study. Each section is followed by a list of selected references. The mechanics of the text are excellent.—R.A.L.

Pharmaceutical Botany by Heber W. Youngken, Ph.M., Ph.D., Sc.D., Professor of Biology and Pharmacognosy, Massachusetts College of Pharmacy. 1951. Seventh Edition. 752 pages. 548 illustrations. The Blakiston Company. Price \$7.00.

The reputation of the first six editions of Dr. Youngken's text is a monument to its usefulness and needs no further comments here. The Seventh Edition has been completely revised and rewritten. New material on plant physiology, metabolism, plant environment and plant anatomy have been added. The material on general botany has been increased to meet the needs of those institutions where the same courses in botany are taken by pharmacy and liberal arts students. This has been done without reducing the pharmaco-botanical subject matter of former editions. Some shift in position of chapters and some combination of chapters has been made in order to give a better se-

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quence to subject matter. The glossary and classified list of reference works has been retained. Again the mechanics of the text, including the illustrations, are excellent. The usefulness of the text is sustained.—R.A.L.

Medicinal Chemistry, Volume I, C. M. Suter, Editor-in-Chief, assisted by an Editorial Board of 9 and 8 Associate Editors, all distinguished men in their respective fields. 1951. 473 pages. John Wiley and Sons, Inc. Price \$12.

Volume I is a series of reviews prepared under the auspices of the Division of Medicinal Chemistry of the American Chemical Society. The publisher's statement about the book presents the following facts and objectives. Each section is written by men actively engaged in industrial research. They are equipped to write from a practical as well as a theoretical standpoint. They summarize the work already done in their specific fields and point out where further research is needed. Each chapter is a self-sufficient unit, supplying the following information about one type of medicinal compound: lists all compounds that have been tested for the type of pharmaceutical activity covered in that chapter; examines the chemical relationship between chemical structure and pharmacological action including groups of compounds, especially in the patent literature for which pharmacological activity has been claimed even when data supporting the claim has not been published; discusses methods of synthesis and pharmacological test procedures for the compounds covered. These are designed to help the reader judge the status of the work in that area, and give selected references to pertinent articles in scientific journals and to the patent literature. Certainly a valuable book for those working in the pharmaceutical area.—R.A.L.

The American Foundation for Pharmaceutical Education has announced the appointment of Commander W. Paul Briggs as its Executive Secretary and Director. Dr. Briggs' resignation from the Navy was accepted as of March 31, 1941 and he assumed his new duties on April 2. Dr. Briggs holds the Bachelor of Science degree from George Washington University, the Master of Science from the University of Maryland, the honorary degree of Doctor of Science from the Philadelphia College of Pharmacy and Science, and the honorary degree of Doctor of Law from Temple University. For a long time he was a member of the faculty and Dean of the College of Pharmacy of George Washington University. He was Commander in the Bureau of Medicine and Surgery U.S.N., 1942-1945. He was Director of the Pharmaceutical Service, Veterans Administration, 1946-1947, and acted as head of the Pharmaceutical Section of the Bureau of Medicine and Surgery U.S.N. with the rank of Commander since 1948. Dr. Briggs is well qualified to carry on the important work of the Foundation in an expanded program which is now being planned by the Directors of that organization.

Montana

Montana State University, School of Pharmacy, Missoula. (1917)
Curtis H. Waldon, Dean.

Nebraska

The Creighton University, College of Pharmacy, Omaha. (1916)
William A. Jarrett, Dean.

University of Nebraska, College of Pharmacy, Lincoln. (1913)
Joseph B. Burt, Dean.

New Jersey

Rutgers University, The State University of New Jersey, New Jersey College of Pharmacy, Newark. (1913)
Roy A. Bowers, Dean

New York

University of Buffalo, School of Pharmacy, Buffalo. (1939)
A. B. Lemon, Dean

Columbia University, College of Pharmacy of the City of New York. (1939)
Charles W. Ballard, Dean.

Fordham University, College of Pharmacy, New York. (1939)
James H. Kidder, Dean

Long Island University, Brooklyn College of Pharmacy, Brooklyn. (1939)
Hugo H. Schaefer, Dean.

Union University, Albany College of Pharmacy, Albany. (1946)
Francis J. O'Brien, Dean

North Carolina

University of North Carolina, School of Pharmacy, Chapel Hill. (1917)
Edward A. Brecht, Dean.

North Dakota

North Dakota Agricultural College of Pharmacy, Fargo. (1923)
William F. Sudro, Dean.

Ohio

Ohio Northern University, College of Pharmacy, Ada. (1935)
Albert C. Smith, Acting Dean

University of Cincinnati, Cincinnati College of Pharmacy. (1947)
J. F. Kowaleski, Dean.

The Ohio State University, College of Pharmacy, Columbus. (1900)
B. V. Christensen, Dean.

University of Toledo, College of Pharmacy, Toledo. (1941)
Charles H. Larwood, Dean

Oregon

Oregon State College, School of Pharmacy, Corvallis. (1916)
George K. Croason, Dean

Pennsylvania

Duquesne University, School of Pharmacy, Pittsburgh. (1937)
Hugh C. Muldoon, Dean.

Philadelphia College of Pharmacy and Science, Philadelphia. (1900)
Ivor Griffith, Dean.

Temple University, School of Pharmacy, Philadelphia. (1933)
Joseph B. Sprowis, Dean.

University of Pittsburgh, School of Pharmacy, Pittsburgh. (1900)
Edward C. Kell, Dean.

Philippines

University of the Philippines, College of Pharmacy, Manila. (1917)
Paterno Valenzuela, Dean.

Puerto Rico

University of Puerto Rico, College of Pharmacy, Rio Piedras. (1936)
Luis Torres-Diaz, Dean.

Rhode Island

Rhode Island College of Pharmacy and Allied Sciences, Providence. (1936)
W. Henry Rivard, Dean.

South Carolina

Medical College of the State of South Carolina, Charleston. (1946)
William A. Prout, Dean.

University of South Carolina, School of Pharmacy, Columbia. (1938)
Emery T. Motley, Dean.

South Dakota

South Dakota State College, Division of Pharmacy, Brookings. (1908)
Floyd J. Leblanc, Dean.

Tennessee

University of Tennessee, School of Pharmacy, Memphis. (1914)
Robert L. Crowe, Dean.

Texas

University of Texas, College of Pharmacy, Austin. (1926)
Henry M. Burlaga, Dean.

Virginia

Medical College of Virginia, School of Pharmacy, Richmond. (1908)
R. Blackwell Smith, Jr., Dean.

Washington

State College of Washington, School of Pharmacy, Pullman. (1913)
Pearl H. Dirstine, Dean.

University of Washington, College of Pharmacy, Seattle. (1908)
Forest J. Goodrich, Dean.

West Virginia

West Virginia University, College of Pharmacy, Morgantown. (1930)
J. Lester Hayman, Dean.

Wisconsin

University of Wisconsin, School of Pharmacy, Madison. (1900)
Arthur H. Uhl, Dean.

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For further information concerning Foundation Fellowships, including application forms, write directly to the

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